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BERGER ASSOCIATES INC HARRISBURG PA
NATIONAL DAM INSPECTION PROGRAM. SWEET ARROW LAKE DAM (NDI-PA-0--ETC(U)
APR 79

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DACW31-79-C-0012

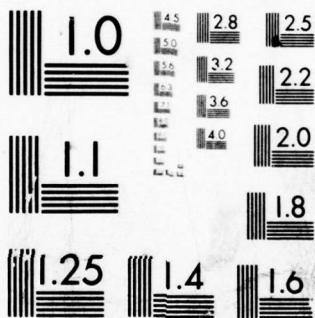
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SWEET ARROW LAKE DAM

NDI NO. PA-00680

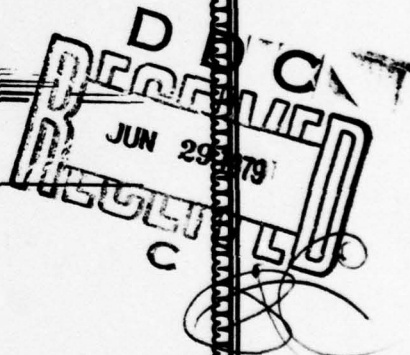
DER NO. 54-102

SCHUYLKILL COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM

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PREPARED FOR
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

BY
✓ Berger Associates, Inc.
Harrisburg, Pennsylvania

APRIL 1979

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PREFACE

This report has been prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS
AND RECOMMENDATIONS

Name of Dam: SWEET ARROW LAKE DAM, NDS NO. PA-00680
State & State No. PENNSYLVANIA, 54-102
County: SCHUYLKILL
Stream: UPPER LITTLE SWATARA CREEK
Date of Inspection: November 8, 1978

Based on the visual inspection, past performance and the available engineering data, the dam and its appurtenant structures appear to be in fair condition.

In accordance with the Corps of Engineers' evaluation guidelines the combination of storage and spillway capacity is capable of passing only 32 percent of the Probable Maximum Flood (PMF) and the spillway is considered to be seriously inadequate. The dam in its present condition is considered to be unsafe, non-emergency.

The following recommendations are made for action by the owner:

1. That a detailed engineering investigation be conducted by a professional engineer, qualified in the design of dam construction, to determine what measures should be taken to improve the capacity of the spillway.
2. That the top of dam and the downstream slope be provided with a protective cover. (11) Apr 79
3. That a procedure be developed and implemented to provide regular maintenance of the embankment slopes and spillway, including the removal of trees and brush on slopes. (12) 114e
4. That the footbridge be supplied with a safe walking platform, and a manhole cover be installed on the intake tower platform.
5. That the blowoff facilities be operated and serviced at least twice a year.

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National Dam Inspection Program, Sweet Arrow Lake Dam (NDI-PA-00680, DER-54-102), Susquehanna River Basin, Schuylkill County, Pennsylvania. Phase I Inspection Report. JOB

6. That a formal surveillance and downstream warning system be developed to be used during periods of high or prolonged precipitation.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

DATE: April 6, 1979



APPROVED BY:

G. L. Withers

G. L. WITHERS
Colonel, Corps of Engineers
District Engineer

DATE 22 Apr 79



OVERVIEW
SWEET ARROW LAKE DAM

TABLE OF CONTENTS

| | <u>Page</u> |
|---|-------------|
| <u>SECTION 1 - PROJECT INFORMATION</u> | |
| 1.1 GENERAL | 1 |
| 1.2 DESCRIPTION OF PROJECT | 1 |
| 1.3 PERTINENT DATA | 3 |
| <u>SECTION 2 - ENGINEERING DATA</u> | |
| 2.1 DESIGN | 6 |
| 2.2 CONSTRUCTION | 6 |
| 2.3 OPERATION | 6 |
| 2.4 EVALUATION | 6 |
| <u>SECTION 3 - VISUAL INSPECTION</u> | |
| 3.1 FINDINGS | 8 |
| 3.2 EVALUATION | 10 |
| <u>SECTION 4 - OPERATIONAL PROCEDURES</u> | |
| 4.1 PROCEDURES | 11 |
| 4.2 MAINTENANCE OF DAM | 11 |
| 4.3 MAINTENANCE OF OPERATING FACILITIES | 11 |
| 4.4 WARNING SYSTEM | 11 |
| 4.5 EVALUATION | 11 |
| <u>SECTION 5 - HYDROLOGY/HYDRAULICS</u> | |
| 5.1 EVALUATION OF FEATURES | 12 |
| <u>SECTION 6 - STRUCTURAL STABILITY</u> | |
| 6.1 EVALUATION OF STRUCTURAL STABILITY | 14 |
| <u>SECTION 7 - ASSESSMENT AND RECOMMENDATIONS</u> | |
| 7.1 DAM ASSESSMENT | 16 |
| 7.2 RECOMMENDATIONS | 16 |
| APPENDIX A - CHECK LIST OF VISUAL INSPECTION REPORT | |
| APPENDIX B - CHECK LIST OF ENGINEERING DATA | |
| APPENDIX C - HYDROLOGY AND HYDRAULIC CALCULATIONS | |
| APPENDIX D - GEOLOGIC REPORT | |
| APPENDIX E - PHOTOGRAPHS | |
| APPENDIX F - PLATES | |

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

SWEET ARROW LAKE DAM

NDS-ID NO. PA-00680

DER-ID NO. 54-102

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

Sweet Arrow Lake Dam is an earthfill embankment with a maximum height of 35.5 feet. The length of the dam crest is about 480 feet. The ends of the embankment tie into the remains of an older and higher dam which failed, due to overtopping, in 1862. A cutoff trench was excavated to solid rock and a grout curtain was installed. The spillway, which has a crest elevation of 14.5 feet below the top of the dam is located in the west (left) abutment, and is separated by a high ridge from the embankment. The 50 feet wide spillway was excavated in rock and is unlined. An intake tower is located at the toe of the upstream slope. The intake is controlled by two 18-inch gate valves and the discharge is through a concrete conduit beyond the downstream toe of the dam.

B. Location:

Pine Grove Township, Schuylkill County
U.S.G.S. Quadrangle, Swatara Hill, PA
Latitude 40°-34.2', Longitude 76°-22.0'
(Appendix F, Plates I and II)

C. Size Classification:

Intermediate (35.5 feet high, 3110
acre-feet)

- D. Hazard Classification: High (Section 3.1.E)
- E. Ownership: Borough of Pine Grove
17 Mifflin Street
Pine Grove, PA 17963
- F. Purpose of Dam: Recreation
- G. Design and Construction History:

The present dam was built on the site of a previous dam which had been constructed as a water supply dam for the Union Canal. That dam was probably about 10 feet higher than the present embankment and failed in June 1862, due to blocking of the spillway by a log jam. The breach width across the valley was about 200 feet as can be noticed from contours on Plate III, Appendix F.

The present dam was designed and constructed by the J. C. White Engineering and Construction Company, New York, for the East Penn Electric Company. The reservoir water was to be used for a power plant located about 3/4 mile downstream. The East Penn Electric Company was later acquired by the Pennsylvania Power and Light Company. The original design was slightly revised on the recommendation of PennDER and a permit for construction was issued on October 12, 1922. Construction started in early 1923 and was completed on December 10, 1923.

H. Normal Operating Procedures

The reservoir at present is used for recreation, fishing and boating. The Borough of Pine Grove acquired the dam for possible future use in their water supply system. All inflow is either stored or discharged over the spillway.

1.3 PERTINENT DATA

A. Drainage Area (square miles)

From files - 19.3
Computed for this report - 20.5

Use 20.5

B. Discharge at Dam Site (cubic feet per second) See Appendix C for hydraulic calculations

Maximum known flood, since construction of dam,
June 22, 1972 based on records for the U.S.G.S.
gaging station, which is located 20 miles downstream
from dam: 7,000

| | |
|---|-------|
| Outlet works low pool outlet at pool Elev. 534.0 | 10 |
| Outlet works at pool level Elev. 548.0 (spillway crest) | 34 |
| Warm water outlet at pool Elev. 548.0 (spillway crest) | 27 |
| Spillway capacity at pool Elev. 562.5 (top of dam) | 8,200 |
| C. <u>Elevation</u> (feet above mean sea level) | |
| Top of dam | 562.5 |
| Spillway crest | 548.0 |
| Upstream portal invert (4.6' x 5.5' conduit) | 523.0 |
| Downstream portal invert (4.6' x 5.5' conduit) | 522.1 |
| Streambed at centerline of dam (Estimated) | 527.0 |
| D. <u>Reservoir</u> (miles) | |
| Length of normal pool | 1.3 |
| Length of maximum pool | 2.5 |
| E. <u>Storage</u> (acre-feet) | |
| Spillway crest (Elev. 548.0) | 1,105 |
| Top of dam (Elev. 562.5) | 3,110 |
| F. <u>Reservoir Surface</u> (acres) | |
| Top of dam (Elev. 562.5) from HEC-1 | 200 |
| Spillway crest (Elev. 548.0) | 92 |
| G. <u>Dam</u> | |
| Type: Homogeneous earthfill with a rockfill slope on the upstream side and a downstream rock toe drain. | |
| Length: 480 feet. | |
| Height: 35.5 feet. | |

Top Width: Total 12 feet consisting of 7 feet impervious material and 5 feet rockfill.

Side Slopes: Upstream - impervious material 2H to 1V
Rockfill 2.35H to 1V above elevation 548.0
and 3H to 1V below spillway crest elevation.

Downstream - 3H to 1V.

Zoning: Rockfill of variable width on upstream side.

Impervious Core: None.

Cutoff: Trench on centerline dam to solid rock with a concrete wall.

Grout Curtain: On centerline of trench, grout holes 20 feet deep on 8 feet centers.

H. Outlet Facilities

There is a eight-foot inside diameter intake tower located 95 feet upstream from the centerline of the dam. Access is by means of a single-span steel-truss bridge from the top of the dam. Water is admitted to the tower through two 18-inch gate valves with centerline elevations 537.0 and 532.5.

Water is released from the tower through a single 18-inch gate valve with centerline elevation of 530.5. Water flows from the discharge valve into the top of the outlet tunnel. The arch type, reinforced concrete tunnel has a cross sectional area of 20 square feet and is 220 feet long. It is uncontrolled at the downstream end and discharges into the natural channel of Upper Little Swatara Creek. The water is not used for any purpose and the valves have not been operated since 1961 (17 years).

I. Spillway

Type: Uncontrolled, unlined, broad crested weir and channel cut through a rock ridge about 120 feet from the left end of the dam.

Length of weir: 50 feet with vertical unlined rock walls.

Crest elevation: 548.0.

Upstream channel: The spillway channel bottom rises slightly for the first 80 feet from the reservoir and there is a slight riffle at the end of that reach. This riffle is the weir that determines the lake elevation at low flows. At greater flows, the lake elevation is determined by the channel friction in the first 200 feet of the channel.

Downstream channel: For the next 120 feet after the riffle, the channel bottom has a downstream slope of 0.0060. At a point about 400 feet from the lake there is a 20-foot high rocky falls which dissipates the stream energy. From that point, a channel with a flat slope returns the water to the natural stream. The total length of the cut is 430 feet with the highest walls being at the point of the riffle, about 80 feet from the lake. The total length of the spillway channel from the lake shore to the junction with the natural channel is about 1,200 feet.

J. Regulating Outlets

See Section 1.3.H.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A. Hydrology and Hydraulics

The files of Pennsylvania Department of Environmental Resources (PennDER) did not contain hydraulic design data for this dam. The Report on application for construction of the dam states that the spillway capacity is 8,500 cfs which was considered ample.

B. Embankment

Design data and analysis for the embankment were not in the files of PennDER. The files of PennDER included, however, the construction drawings (Plates III and IV, Appendix F) and bi-weekly progress charts. The Report on application for construction describes the proposed construction. Test pits were excavated at numerous locations. The report indicates that at the left side, the subsurface was clay with old roots and on the right side clay was encountered on the upstream side and shaly gravel further downstream. Rock was, in general, 2 to 10 feet below the surface and consisted of fractured sandstone and some shale.

PennDER recommended that the cutoff trench be excavated to sound rock and that the rock be tested by drilling holes not farther than 50 feet apart and to pressure test these holes. If the rock strata was found to be pervious, the rock had to be grouted in holes 20 feet deep and not farther than 8 feet apart. A cutoff wall, 3 feet high, was to be constructed in the centerline of the trench.

The cutoff trench is located on the centerline of the dam except near the right abutment, where it curves upstream. The trench does not extend into the side hills beyond the abutments.

The dam was designed as a homogeneous embankment with a rock-fill on the upstream side. Borrow material was obtained from the left side of the reservoir a short distance upstream of the dam and consisted of a sandy clay. A rock toe drain to elevation 537.0 is provided on the downstream side.

C. Appurtenant Structures

The only available design data is shown on the construction drawings in Appendix F. Design criteria is not available. The intake tower was founded on rock and is a reinforced concrete circular tower with two 18-inch gate valve controlled inlets. The water is discharged through another 18-inch gate valve into the top of an arch shaped reinforced concrete conduit. This conduit had a direct opening to the upstream

side of the tower during the construction phase, but this opening was blocked off with concrete after construction was completed. The conduit has four seepage collars and ends 10 feet beyond the downstream toe of the dam. Access to the intake tower is from the breast of the dam by a truss supported footbridge.

The spillway is located away from the dam and is excavated into rock. No lining was required and the discharge channel makes a plunge at about 400 feet from the beginning of the spillway and joins the old streambed 600 feet downstream from the dam. The channel was to be excavated on a slope of about 0.6 percent.

2.2 CONSTRUCTION

Construction of the dam and appurtenant structures was accomplished under supervision of a resident engineer. Bi-weekly progress charts are available in the files and one, dated November 15, 1923, is included as Plate V in Appendix F. Inspection reports by PennDER indicate that construction was done in accordance with the plans. Pressure testing of the rock strata after the trench was excavated, indicated the need for pressure grouting. Testing after the grouting was completed indicated that the grouting was effective. Plate V, Appendix F, shows that no grouting was done under the conduit because the conduit had been constructed before the cutoff trench was excavated. After construction was completed, inspection reports indicate that some seepage occurred adjacent to the conduit outlet.

2.3 OPERATION

No records of operation were available in the PennDER files. One letter indicates that the dam was nearly overtopped in August 1933. The Borough of Pine Grove bought the reservoir and dam from PP&L in 1973 for possible future use as a domestic water supply. At present, the reservoir is used for recreation only and the gate valves are not operated at all. Seepage has been noticed at the conduit outlet for many years. Inspection reports indicate that the downstream slope was never seeded or sodded.

2.4 EVALUATION

A. Availability

The available engineering data was limited to construction drawings and some reports by PennDER. Actual design criteria and design analysis were not in the files.

B. Adequacy

1. Hydrology and Hydraulics

There is not sufficient information available to evaluate the design criteria for this dam. However, the construction drawings are sufficient to review the hydraulic adequacy of this facility for this report.

2. Embankment

There is no data available on the soil parameters of the borrow material and no results of compaction tests. This prevents the review of the stability and seepage adequacy of the embankment. The embankment was, however, detailed in accordance with acceptable engineering practice.

3. Appurtenant Structures

The available construction drawings are sufficient to review the adequacy of the structures.

C. Operating Records

Formal operating records have not been maintained for these facilities. It appears that maintenance procedures have been lacking and that the gate valves have not been operated since 1961.

D. Post Construction Changes

No changes or additions have been reported since the construction was completed in 1923.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of Sweet Arrow Lake Dam is fair. Present maintenance procedures are limited. The dam and lake were acquired by the Borough of Pine Grove in 1973 from PP&L for future use as a water supply. At present, the lake is used for fishing only. The Pennsylvania Fish Commission stocks the reservoir. The inspection team was accompanied by Mr. Frank Winsheimer, Borough Council President and Mr. Harold Zimmerman, Works Manager of the Borough. The visual inspection check list is in Appendix A of this report. Photographs taken during the inspection are reproduced in Appendix E.

B. Embankment

The upstream embankment slope is protected with a rockfill, but a considerable amount of brush is growing on this slope. The breast of the dam was level and straight (see survey Appendix A) and consisted of dirt and some small gravel. The edges were rounded off, causing an uneven width. The downstream slope was covered with some grass, weeds, brush and small and large trees. Motor bike traffic has caused three bare tracks on the slope and these tracks are susceptible to erosion. The dam was constructed on the site of a previous dam and the remnants of this old dam, which was higher than the present one, are easy to detect where the new dam ties into the hillside. The downstream slope was dry except two pools of standing water at the toe. No movement of water was detected and the amount of seepage is probably minimal. One pool was the outlet for the conduit. A rock toe drain is visible.

C. Appurtenant Structures

The intake tower is located about half way between the abutments of the dam and is accessible by a footbridge. Most of the planking on the steel truss bridge has disappeared and the inspector had to climb along the truss chord to check the intake tower. The manhole cover on the tower was missing and the owners representatives stated that the valves had not been operated since 1961. In 1974 an effort was made to operate the valves, but no movement was obtained. The valves are on 18-inch pipes and if operable, could be used to draw down the reservoir to an elevation of 531.0.

The conduit outlet ends in a small pool, which is closed off by a dirt access road (See Plate A-II, Appendix A), and prevents a free flow. Considerable siltation has occurred in the conduit. It appears, however, that sufficient opening is still available in the large conduit to pass the discharge flow of the 18-inch upstream blowoff valve.

The spillway is located in the left hillside beyond the previous dam abutment. The channel is cut in the rock and was in good condition. There is no concrete weir and some brush near the left entrance causes a small obstruction. The discharge channel is rather flat over the first 300 feet and then drops vertically over natural rock to the stream.

D. Reservoir Area

Some of the banks around the reservoir are steep and wooded. A highway parallels the north bank of the lake (Plate II, Appendix F). The reservoir banks on that side of the reservoir are flat and used as farmland. All banks are stable and no sedimentation has been reported.

E. Downstream Channel

The spillway channel joins the natural stream about 600 feet downstream from the dam. This stream, with wooded banks, crosses a highway another 1500 feet further downstream. Several houses are located near the stream in this area and it is expected that the hazard to loss of life would increase significantly if the dam would fail due to overtopping. The hazard category is therefore considered to be "High".

3.2 EVALUATION

The dam and appurtenant works appear to be in need of maintenance. The structural integrity of the dam appears to be good, but preventive maintenance is required. Brush and trees should be removed from the slopes, tracks and the top of the dam should be seeded. Access to the intake tower should be provided by installing planking and the gate valves on the 18-inch pipes should be made operable.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURE

The dam and reservoir were bought by the Borough for possible future use as a domestic water supply. At present the reservoir is used for fishing and picnicking and no operational procedures have been established.

4.2 MAINTENANCE OF DAM

Maintenance is presently not performed on the dam embankment.

4.3 MAINTENANCE OF OPERATING FACILITIES

At present the facilities are not used and no maintenance procedures exist.

4.4 WARNING SYSTEM

A formal warning system or surveillance procedure has not been established. The dam is policed, but no regular visitation by Borough personnel is maintained.

4.5 EVALUATION

Operational procedures do not exist at the present time. It is recommended that a regular maintenance schedule for the embankment and operating facilities be developed. A formal surveillance and downstream warning system should be established to be used during periods of heavy or prolonged precipitation.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analyses available from PennDER for Sweet Arrow Lake Dam were not very extensive. No frequency curve, unit hydrograph, nor flood routings were submitted by the designer to PennDER. A Pennsylvania Water Supply Commission report in the file stated that the spillway capacity was 8,500 cfs or 450 cfs per square mile. It was further stated that it would take 4-1/2 to 5 hours to overtop the dam if the runoff were to be 500 cfs per square mile.

B. Experience Data

The present dam was built in 1923 to supply cooling water for a coal-fired generating plant of the East Penn Electric Company (now PP&L). Calculations based on the records of the U.S.G.S. gaging station at Harper Tavern indicate that the greatest flood since 1923 occurred on June 22, 1972 and produced an inflow to the reservoir of about 7,000 cfs. The project passed that flood without damage.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event, until the dam is overtopped.

There is some brush growing in the spillway channel which should be removed.

D. Overtopping Potential

Sweet Arrow Lake Dam has a total storage capacity of 3,110 acre-feet and an overall height of 35.5 feet, both referenced to the top of the dam. These dimensions indicate a size classification of "Intermediate". The hazard classification is "High" (see Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is the Probable Maximum Flood (PMF). For this dam, the PMF peak inflow is 29,817 cfs (see Appendix C for HEC-1 inflow computations).

Comparison of the estimated PMF peak inflow of 29,817 cfs with the estimated spillway discharge capacity of 8,030 cfs indicates that a potential for overtopping of the Sweet Arrow Lake Dam exists.

An estimate of the storage effect of the reservoir and routing of the computed inflow hydrograph through the reservoir shows that this dam does not have the necessary storage available to pass the PMF without overtopping. The spillway-reservoir system can pass a flood event equal to 32% of a PMF.

Improving the embankment by eliminating the low area in the top of the dam will not significantly increase the capacity of the spillway-reservoir system.

E. Dam Break Evaluation

The calculations to determine the behavior of the dam in the event of an overtopping and a resulting breaching of the embankment indicates a substantial increase in water levels downstream from the dam.

Several houses are located near the stream about 2,400 feet downstream from the dam where State Route 443 crosses the stream. On the basis of the results of a dam break analysis, using the U.S. Army Corps of Engineers' HEC-1 computer program, the water surface elevation in the vicinity of the houses would be about 533.3 when the water surface in the reservoir above the dam is just at the low point elevation of the embankment (no overtopping). (Refer to Table 1, Appendix C). It is expected that 34 percent of the PMF would cause the water level in the lake to reach an elevation that would result in a breach (.5 foot above crest elevation). Just prior to failure by the 34 percent PMF flow, the water surface elevation 2,400 feet downstream would be about 533.7. The increase due to overtopping under no failure condition would be about $(533.7 - 533.3)$.4 feet. While more property would be exposed to flooding, the increase to the danger of loss of life is not considered significant. With failure, however, the breaching analysis indicates a rise of 8.9 feet above the flow level just prior to breach when considering a 15 minute time to complete the breach and a 5.3 feet rise above flow level just prior to breach when considering a 2-hour time to complete the breach. The increase in hazard to loss of life and property damage is reflected not only in the increase in depth of water of about 8.9 feet in the 15-minute breach and about 5.3 feet in the 2-hour breach, but more significantly in the shorter time to reach the peak, less time would be available to respond to the flooding under the breach conditions.

Being an earth embankment, it is judged that a breach is likely to develop when the depth of flow over the crest is 0.5 foot or greater and that the breach will be completed between the 15 minute and the 2-hour period. The numerical difference of water levels is about

3.6 feet. The property damage would be similar with either time. Again, however, the time factor is most significant regarding loss of life. Calculations indicate that the water depth will increase at a rate of about 8.9 feet in one-half hour under the 15-minute breach condition.

F. Spillway Adequacy

The intermediate size category, in accordance with the Corps of Engineers criteria and guidelines, indicates that the Spillway Design Flood (SDF) for this dam should be the full Probable Maximum Flood (PMF).

Calculations show that the spillway discharge capacity and reservoir storage capacity combine to handle 32% of the PMF (Refer to Sheet 15 of Appendix C).

Since the spillway discharge and reservoir storage capacity cannot pass one-half of the PMF without overtopping and failure of the dam, and because the downstream hazard to loss of life is high and this hazard is significantly increased when the dam is overtopped as compared to just prior to overtopping, the spillway is judged to be seriously inadequate.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observation

1. Embankment

There were no visual indications of undue embankment stresses or sloughage and the slopes appear to be stable and adequate. To prevent further erosion of the downstream slope, this slope should be seeded. Seepage near the conduit outlet could not be observed due to the presence of a pool of water. The downstream slope was dry and no seepage was detected.

2. Appurtenant Structures

The spillway is in good condition and the rock cut does not appear to have an erosion problem. The discharge is at a considerable distance from the embankment and no damage could occur. Although deterioration of the concrete intake tower has occurred, the tower is considered to be in acceptable structural condition at the present. The gate valves are not operable at present and it is recommended that blowoff facilities should be made operable for emergencies.

B. Design and Construction Data

1. Embankment

The available construction data indicates that the embankment was designed and constructed in accordance with good engineering practice. The rock strata was not grouted under the conduit and this could allow some seepage at the downstream conduit outlet. The rock toe drain is also directing all seepage to this low point.

2. Appurtenant Structures

The available data indicates that all structures were well designed, detailed and adequately reinforced.

C. Operating Records

The only available records are inspection reports by PennDER, which indicate that the two main problems were the omission of seeding the downstream slope and some seepage near the conduit outlet. Brush and tree growth on the embankment slopes and in the spillway entrance have been reported repeatedly, indicating poor maintenance procedures.

D. Post Construction Changes

No reported modifications have been made to the original dam design.

C. Seismic Stability

This dam is located in Seismic Zone 1 and it is considered that the static stability is sufficient to withstand minor earthquake induced dynamic forces. No studies or calculations have been made to confirm this assumption.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection, the review of available design data and the operational history indicates that Sweet Arrow Lake Dam is in fair condition and has been designed in accordance with acceptable engineering practice. The maintenance procedures for the embankment and facilities are poor.

In accordance with the Corps of Engineers' evaluation guidelines, the combination of storage and spillway capacity is sufficient to pass only 32 percent of the Probable Maximum Flood (PMF). Overtopping of the dam with an inflow of 34 percent of the PMF could cause failure of the dam. Such a failure would significantly increase the hazard to loss of life downstream. The spillway is, therefore, considered to be seriously inadequate, and the dam is unsafe, non-emergency.

B. Adequacy of Information

The available data is considered sufficient to make a reasonable assessment of the embankment and facilities.

C. Urgency

Because of the serious inadequacy of the spillway and the "High" hazard classification of the facilities, it is considered important that the recommendations presented in this report be implemented at once.

D. Necessity for Additional Studies

The results of this inspection indicate the need for additional detailed hydrologic and hydraulic studies to determine the requirements for improving the capacity of the dam.

7.2 RECOMMENDATIONS

A. Facilities

The following recommendations are presented for action by the owner:

1. That a detailed engineering investigation be conducted by a professional engineer, qualified in the design of dam construction, to determine what measures can be taken to improve the capacity of the spillway.
2. That the top of the dam and the downstream slope be provided with a protective cover against erosion.
3. That the footbridge be supplied with a safe walking platform.
4. That a manhole cover be provided on the intake tower.

B. Operation and Maintenance Procedures

It is recommended that the owner initiate the following maintenance procedures:

1. A regular maintenance procedure of the embankment slopes and crest of dam, which will include removal of trees, brush and high weeds.
2. A twice a year schedule of greasing and operation of the drawdown valves.
3. Removal of brush in the spillway entrance.
4. The development of a formal surveillance and downstream warning system to be used during periods of high or prolonged precipitation.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

APPENDIX A

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 54-102

NDI NO. PA-00 680

NAME OF DAM Sweet Arrow Lake HAZARD CATEGORY High

TYPE OF DAM Earthfill

LOCATION Pine Grove TOWNSHIP Schuylkill COUNTY, PENNSYLVANIA

INSPECTION DATE 11/8/78 WEATHER Cloudy TEMPERATURE 50's

INSPECTORS: H. Jongsma (Recorder)

OWNER'S REPRESENTATIVE(s):

A. Bartlett

Frank Zimmerman

R. Steacy

Harold Winsheimer

NORMAL POOL ELEVATION: 548.0

AT TIME OF INSPECTION:

BREAST ELEVATION: 562.5

POOL ELEVATION: 548.0+

SPILLWAY ELEVATION: 548.0

TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: 553.7 (Estimated)

GENERAL COMMENTS:

Valves last opened in 1961. Have tried to open but no movement in 1974.
Conduit outlet underwater in a pool.
Used by Pennsylvania Fish Commission for fishing.
Bought in 1973 by Borough of Pine Grove from PP&L for possible use
as water supply.

VISUAL INSPECTION
EMBANKMENT

| | OBSERVATIONS AND REMARKS |
|--|--|
| A. SURFACE CRACKS | None observed on breast of dam (dirt). |
| B. UNUSUAL MOVEMENT BEYOND TOE | None detected. |
| C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES | Three bike and erosion tracks on downstream slope. Abutments tie into previous dam abutment. |
| D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL: | Good. Irregular breast width due to rounding of edges. Good. (See survey sketch). |
| E. RIPRAP FAILURES | None. |
| F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY | Good abutment junctions. Spillway cut out of hillside and away from dam. |
| G. SEEPAGE | Pool at conduit outlet. No water movement noticeable. |
| H. DRAINS | Rockfill toe. |
| J. GAGES & RECORDER | None. |
| K. COVER (GROWTH) | Upstream - loose riprap and brush. Breast - dirt. Downstream - some grass, weeds, brush and trees. |

VISUAL INSPECTION
OUTLET WORKS

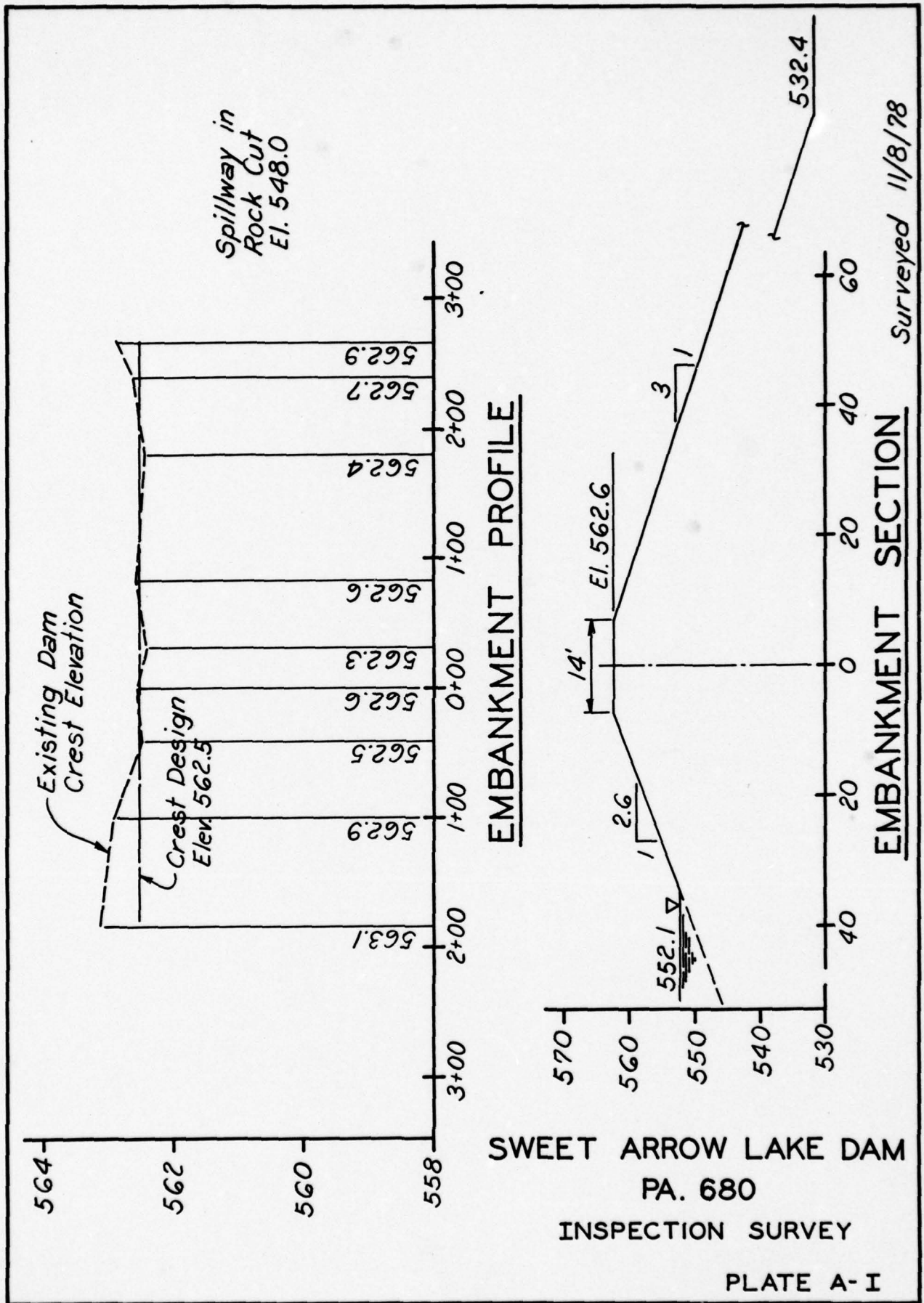
| | OBSERVATIONS AND REMARKS |
|---------------------------|--|
| A. INTAKE STRUCTURE | Circular concrete tower on upstream side. Concrete top deteriorating. Manhole cover missing. |
| B. OUTLET STRUCTURE | Concrete conduit outlet underwater in a pool formed by roadway. |
| C. OUTLET CHANNEL | Blocked by roadway without a pipe. Wide valley available for discharge. |
| D. GATES | Three operator stands on top of tower. None operated since 1961. |
| E. EMERGENCY GATE | Not operable - 18" valve. |
| F. OPERATION & CONTROL | None. |
| G. BRIDGE (ACCESS) | Truss footbridge from top of dam. Most planking has disappeared. Hazardous to cross. |

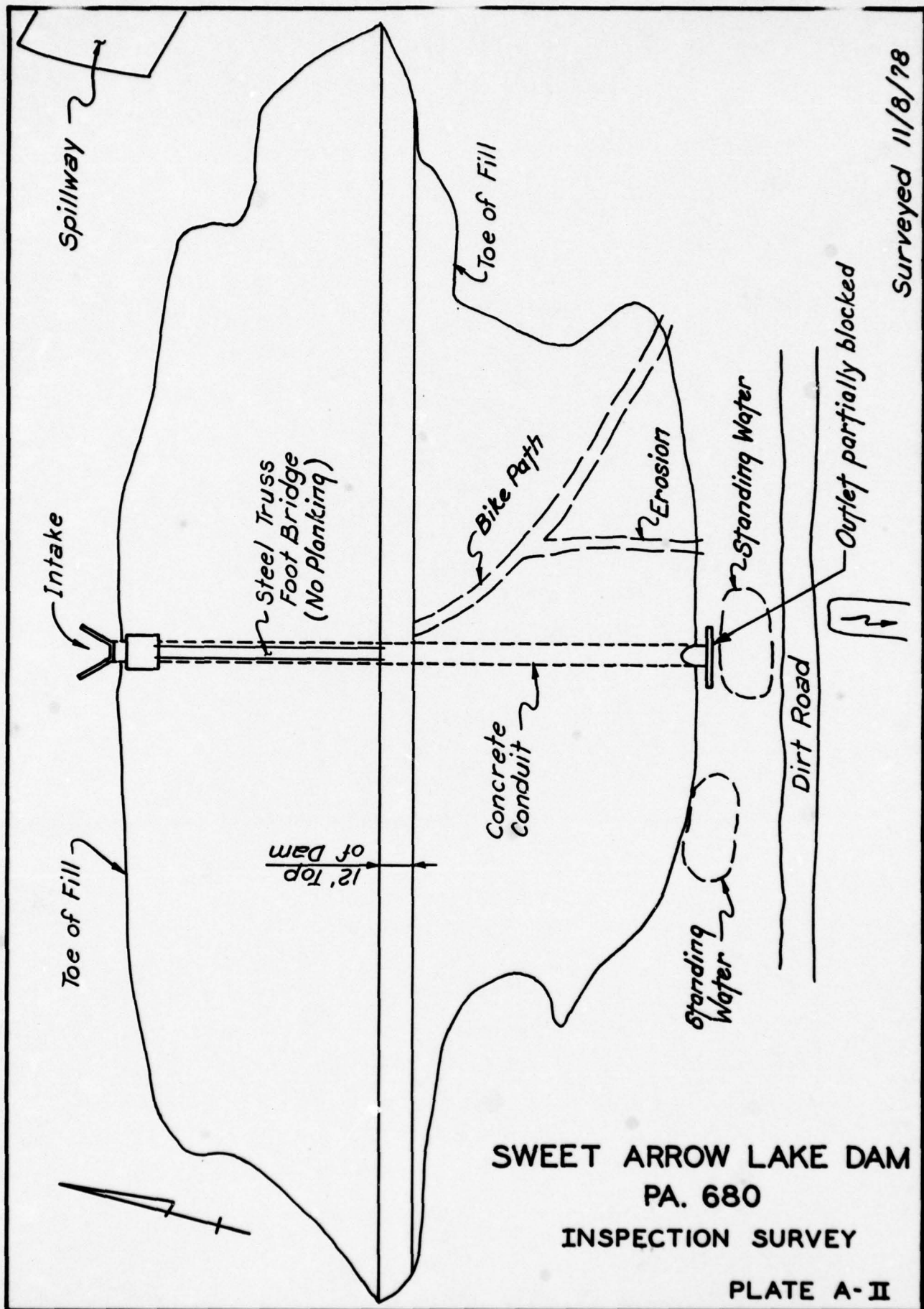
VISUAL INSPECTION
SPILLWAY

| | OBSERVATIONS AND REMARKS |
|---|--|
| A. APPROACH CHANNEL | Cut in rock. Some brush growing near left abutment. |
| B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments | None - rock cut. |
| C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin | Cut in rock. Good condition. Drop of at least 15 feet at end in natural stream. |
| D. BRIDGE & PIERS | None. |
| E. GATES & OPERATION EQUIPMENT | None. |
| F. CONTROL & HISTORY | None. Maximum water surface estimated at 5.7 feet during Agnes (1972) above spillway (1 foot above road). |

VISUAL INSPECTION

| | OBSERVATIONS AND REMARKS |
|---------------------------|---|
| <u>INSTRUMENTATION</u> | |
| Monumentation | None. |
| Observation Wells | None. |
| Weirs | None. |
| Piezometers | None. |
| Staff Gauge | None. |
| Other | |
| <u>RESERVOIR</u> | |
| Slopes | Some steep, some flat in built up area (houses, roadway). |
| Sedimentation | None. |
| Watershed Description | Mostly farmland, except wooded in the mountains. |
| <u>DOWNSTREAM CHANNEL</u> | |
| Condition | Natural stream. |
| Slopes | Stable. |
| Approximate Population | 200 in Pine Grove. |
| No. Homes | 4 houses nearby. |





APPENDIX B
CHECKLIST OF ENGINEERING DATA

APPENDIX B

CHECK LIST
ENGINEERING DATA

PA DER # 54-102

NDI NO. PA-00 680

NAME OF DAM Sweet Arrow Lake

| ITEM | REMARKS |
|---|--|
| AS-BUILT DRAWINGS | None. |
| REGIONAL VICINITY MAP | U.S.G.S. Quadrangle Swatara Hill, PA See Plate II, Appendix F |
| CONSTRUCTION HISTORY | Constructed by J.C. White Construction Corporation, New York in 1923 at the site of an older and higher dam, which failed in 1862. |
| GENERAL PLAN OF DAM | See Plate III, Appendix F. |
| TYPICAL SECTIONS OF DAM | See Plate III, Appendix F. |
| OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS | See Plate III and IV, Appendix F. None. None. |

ENGINEERING DATA

| ITEM | REMARKS |
|---|--|
| RAINFALL & RESERVOIR RECORDS | None. |
| DESIGN REPORTS | None, except Report on the application for permit to construct by DER. |
| GEOLOGY REPORTS | None. |
| DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES | None. |
| MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD | None. Test pits on general plan show top of rock. |
| POST CONSTRUCTION SURVEYS OF DAM | None. |
| BORROW SOURCES | Probably on the left side upstream of the dam. |
| | |

ENGINEERING DATA

| ITEM | REMARKS |
|--|---|
| MONITORING SYSTEMS | None. |
| MODIFICATIONS | None. |
| HIGH POOL RECORDS | None. |
| POST CONSTRUCTION ENGINEERING STUDIES & REPORTS | None |
| PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports: | A dam at this site constructed for the Union Canal failed in August 1862, due to overtopping as a result from a log jam in the spillway. None. |
| MAINTENANCE & OPERATION RECORDS | None. |
| SPILLWAY PLAN, SECTIONS AND DETAILS | Plate III, Appendix F. |

ENGINEERING DATA

| ITEM | REMARKS |
|---|---|
| OPERATING EQUIPMENT, PLANS & DETAILS | Plate IV, Appendix F. |
| CONSTRUCTION RECORDS | Bi-weekly progress charts in files. One chart reproduced as Plate V, Appendix F. Inspection Reports by DER. Construction photographs. |
| PREVIOUS INSPECTION REPORTS & DEFICIENCIES | Inspection reports by DER indicate that downstream slope was not seeded and that upstream slope was irregular. Seepage has been noticed at the conduit outlet, except recently due to the presence of a small pool. Brush and tree growth has been reported many times. |
| MISCELLANEOUS | Original construction drawing dated August and September 1922 have been superseded by the drawings reproduced in Appendix F. Changes were made at the request of DER. |

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: _____

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 548.0 Acre-Feet: 1105

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev. 562.5 Acre-Feet: 3110

MAXIMUM DESIGN POOL: Elev. Unknown

TOP DAM: Elev. 562.5

SPILLWAY:

a. Elevation 548.0

b. Type Uncontrolled, unlined broadcrested weir and channel cut
through rock.

c. Width 50

d. Length 400

e. Location Spillover In left abutment.

f. Number and Type of Gates None.

OUTLET WORKS:

a. Type Reinforced concrete tower and arch shaped conduit.

b. Location Tower at upstream toe of dam.

c. Entrance inverts 531.75

d. Exit inverts 522.1

e. Emergency drawdown facilities 18-inch gate valve.

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 8200 cfs (spillway)

APPENDIX C

HYDROLOGY AND HYDRAULIC CALCULATIONS

APPENDIX C

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

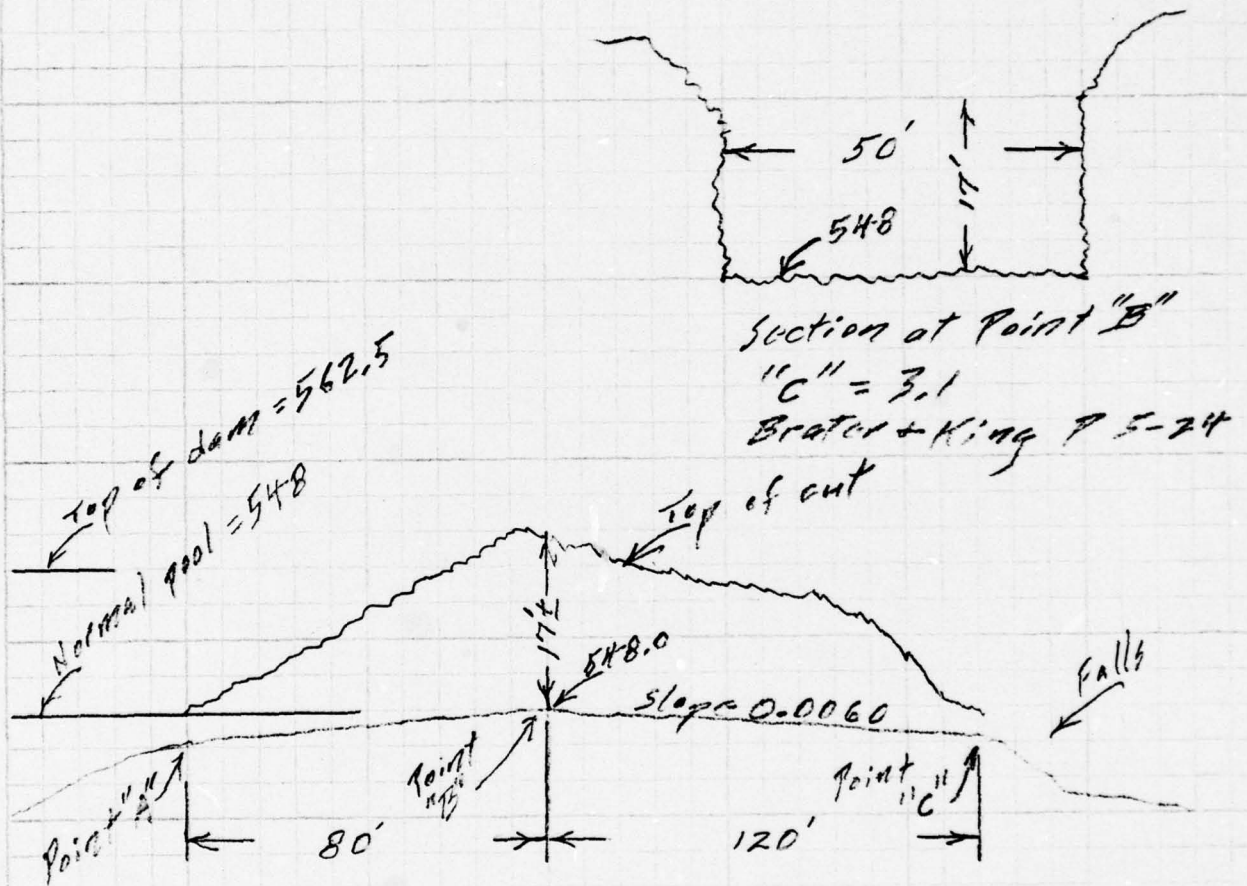
The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

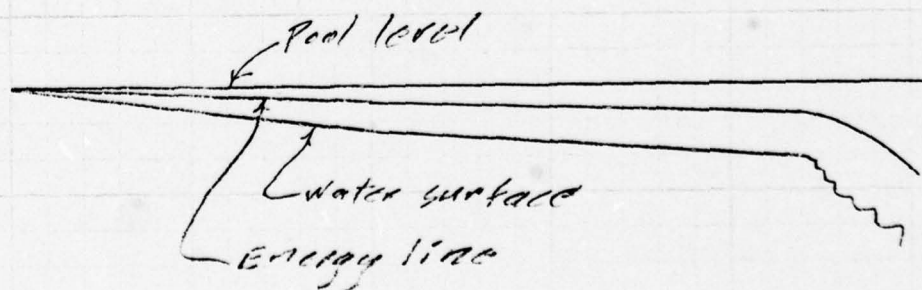
For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

Spillway Rating

Spillway is sunlined, rectangular cut through rock ridge 120 feet from left end of dam. Width 50 feet, crest elevation 548.0



Profile along cut.



Spillway Rating (Cont.)

Pool level 562.5 (top of dam)

Assume $Q = 7,000$ cfs

compute friction drop Pt. "A" to Pt. "B"

$$V = \frac{1.486}{n} r^{2/3} s^{1/2}$$

$$s^{1/2} = \frac{V \times n}{1.486 \times r^{2/3}}$$

$$s^{1/2} = \frac{9.66 \times 0.03}{1.486 \times (9.18)^{2/3}}$$

$$= \frac{0.290}{6.52}$$

$$= 0.0445$$

$$s = 0.00198$$

$$V = \frac{7,000}{50 \times (562.5 - 548)}$$

$$= \frac{7,000}{725} = 9.66 \text{ ft/sec.}$$

$$n = 0.03$$

$$r = \frac{725}{50 + 14.5 + 14.5} = \frac{725}{79}$$

$$= 9.18 \text{ ft}$$

$$\text{Friction drop} = 0.00198 \times 80 = 0.16 \text{ ft.}$$

compute Q as broad crested weir at point "B"

$$Q = C L H^{3/2}$$

$$= 3.1 \times 50 \times (14.3)^{3/2}$$

$$= 8,382 \text{ cfs}$$

$$C = 3.1$$

$$L = 50 \text{ ft.}$$

$$H = 562.5 - 0.2 - 548.0$$

$$= 14.3 \text{ ft.}$$

compute Q in channel Point "B" to Point "C"

Assume velocity head at "B" = 4.1 ft

$$\text{Depth at "B"} = 562.5 - 0.2 - 4.1 - 548 = 10.2 \text{ ft.}$$

$$\text{Velocity at "B"} = \frac{8382}{50 \times 10.2} = 16.4 \text{ ft/sec.}$$

$$\text{Velocity head} = \frac{V^2}{2g} = \frac{(16.4)^2}{64.3} = 4.18 \text{ ft.}$$

Spillway Rating (Cont)

Assume water surface slope = bottom slope = 0.0060 ft/ft

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

$$n = 0.03$$

$$V = \frac{1.486}{0.03} \times (7.19)^{2/3} \times (0.0060)^{1/2} \quad r = \frac{50 \times (562.5 - 0.2 - 4.2 - 548)}{50 + 10.1 + 10.1}$$

$$= 49.5 \times 3.73 \times 0.0775$$

$$= \frac{505}{70.2} = 7.19 \text{ ft}$$

$$= 14.3 \text{ ft/sec}$$

$$S = 0.0060$$

$$Q = AV = 50 \times 10.1 \times 14.3$$

$$= 7,221 \text{ cfs} \quad (h_v = 3.18' \neq 4.2' \text{ TRY AGAIN})$$

Recompute with new velocity head at "B"

$$\text{Velocity at "B"} = \frac{7220}{50 \times 10.2} = 14.2 \text{ ft/sec}$$

$$\text{Velocity head} = \frac{V^2}{2g} = \frac{(14.2)^2}{64.3} = 3.14 \text{ ft}$$

$$V = \frac{1.486}{0.03} \times (7.73)^{2/3} \times 0.0775 \quad \left\{ \begin{array}{l} r = \frac{50(562.5 - 2 - 3.1 - 548)}{50 + 11.2 + 11.2} \\ = \frac{560}{72.4} = 7.73 \text{ ft} \end{array} \right.$$

$$= 49.5 \times 3.91 \times 0.0775$$

$$= \frac{560}{72.4} = 7.73 \text{ ft}$$

$$= 15.0 \text{ ft/sec}$$

$$Q = 50 \times 11.2 \times 15.0$$

$$= 8,400 \text{ cfs}$$

Try $Q = 8,000 \text{ cfs}$

$$\text{Velocity at "B"} = \frac{8,000}{50 \times 11.0} = 14.54 \text{ ft/sec}$$

$$\text{Velocity head} = \frac{V^2}{2g} = \frac{(14.54)^2}{64.3} = 3.29 \text{ ft}$$

Spillway Rating (Cont)

$$V = \frac{1.486}{0.03} \times (7.64)^{2/3} \times 0.0775$$

$$= 49.5 \times 3.88 \times 0.0775$$

$$= 14.88 \text{ ft/sec}$$

$$Q = AV = 50 \times 11.0 \times 14.88$$

$$= 8,184 \text{ cfs}$$

$$\text{Use } 8,200 \text{ cfs}$$

$$r = \frac{50(562.5 - 2 - 3.3 - 548)}{50 + 11.0 + 11.0}$$

$$= \frac{550}{72} = 7.64 \text{ ft}$$

Spillway Rating (cont)

Flood of June 22, 1972

Town of Pine Grove manager reported lake level was one foot over right bank highway at peak of 1972 flood. Levels indicated this level to be 5.7 ft over spillway crest.

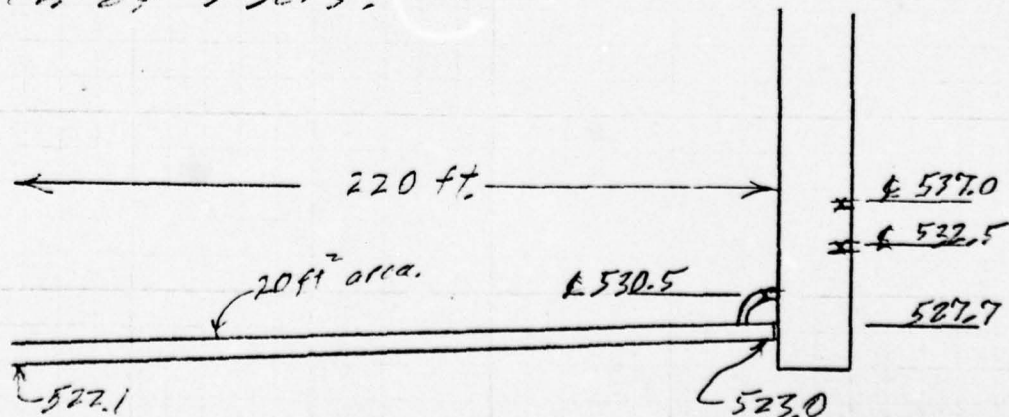
$$Q = C L H^{3/2} = 3.1 \times 50 \times (5.7)^{3/2} = 2,100 \text{ cfs outflow.}$$

For USGS gage at Harper Tavern for flood of June 22, 1972

Drain. Area 337 sq mi, $Q = 66,700 \text{ cfs}$

$$\left(\frac{20.5}{337}\right)^{.8} \times 66,700 = 7,100 \text{ cfs use 7,000 inflow.}$$

Outlet works There is a ten-foot diameter intake tower located 95 ft upstream from the center line of the dam. It is connected to the downstream side of the dam by a conduit having a length of 220 ft and a cross-sectional area of 20 sq ft. Water is admitted to the tower through 18-inch gate valves having elevations of 537.0 and 532.5. Water is delivered from the tower to the outlet conduit through an 18-inch gate valve with an elev. of 530.5.



Outlet Works (cont.)

Pool Elev. 534

$$Q = C a \sqrt{2gh} \quad C = 0.6 \quad a = \pi(0.75)^2 = 1.77 \text{ ft.}^2$$

$$h = 534 - 532.5 = 1.5 \text{ ft.}$$

$$= 0.6 \times 1.77 \times (64.3 \times 1.5)^{1/2}$$

$$= 10.4 \text{ cfs}$$

Pool Elev. 548.0 All 3 valves open.

Assume water surface ^{elev.} in tower = 544

Head on each intake valve = 548 - 544 = 4.0

$$Q_{\text{each valve}} = C a \sqrt{2gh}$$

$$= 0.6 \times 1.77 \times (64.3 \times 4)^{1/2}$$

$$= 17.03 \text{ cfs}$$

Both valves = 2 x 17.03 = 34.06 cfs

Head on discharge valve = 544 - 527.7
 = 16.3 ft.

$$Q_{\text{disch valve}} = C a \sqrt{2gh}$$

$$= 0.6 \times 1.77 \times (64.3 \times 16.3)^{1/2}$$

$$= 34.38 \text{ cfs}$$

Use $Q = 34 \text{ cfs}$

Warm Water Outlet - Pool Elev. 548.0

Intake valve at 537.0 and outlet valve open.
 Water in tower at elev. $\frac{548 + 527.7}{2} = 537.8$

$$Q = C a \sqrt{2gh} \quad h = 548 - 537.8 = 10.2 \text{ ft.}$$

$$= 0.6 \times 1.77 \times (64.3 \times 10.2)^{1/2}$$

$$= 27.2 \text{ cfs}$$

BY DJR DATE 1/15/79

BERGER ASSOCIATES

SHEET NO. 7 OF 15

CHKD. BY _____ DATE _____

PROJECT D8490SUBJECT SWEET ARROW LAKEEFFECTIVE SPILLWAY WEIR COEFFICIENT:

$$Q = C_w L H^{3/2}$$

$$C_w = \frac{Q}{L H^{3/2}} = \frac{8200}{50 \times (14.5)^{1.5}} = 2.97 \leftarrow$$

SPILLWAY RATING : EFFECTIVE WEIR COEF $CW = 2.97$

ELEV. 549 $Q = 2.97 \times 50 \times 1^{1.5} = 148.5 \text{ cfs}$

ELEV. 551 $Q = 2.97 \times 50 \times 3^{1.5} = 772 \text{ cfs}$

ELEV. 554 $Q = 2.97 \times 50 \times 6^{1.5} = 2182 \text{ cfs}$

ELEV. 558 $Q = 2.97 \times 50 \times 10^{1.5} = 4696 \text{ cfs}$

ELEV. 562.3 $Q = 2.97 \times 50 \times 14.3^{1.5} = 8030 \text{ cfs}$

ELEV. 562.6 $Q = 2.97 \times 50 \times 14.6^{1.5} = 8285 \text{ cfs}$

ELEV. 562.7 $Q = 2.97 \times 50 \times 14.7^{1.5} = 8370 \text{ cfs}$

ELEV. 562.9 $Q = 2.97 \times 50 \times 14.9^{1.5} = 8541 \text{ cfs}$

ELEV. 564 $Q = 2.97 \times 50 \times 16^{1.5} = 9504 \text{ cfs}$

ELEV. 563.1 $Q = 2.97 \times 50 \times 15.1^{1.5} = 8713 \text{ cfs}$

ELEV. 564 $Q = 2.97 \times 50 \times 18^{1.5} = 11340$

ELEV. 570 $Q = 2.97 \times 50 \times 22^{1.5} = 15324 \text{ cfs}$

ELEV. 566.1 $Q = 11435$

ELEV. 566.5 $Q = 11816$

ELEV. 567
 $Q = 12299$

EMBANKMENT RATING :

ELEV. 562.6 $Q_1 = 2.7 \times (28 + 59) (.15)^{1.5} = 14$

$Q_2 = 2.7 \times (91 + (\frac{2}{3})62) (.1)^{1.5} = 11$

$Q = 25 \text{ cfs}$

ELEV. 562.9 $Q_1 = 2.7 \times 62 \times (.2)^{1.5} = 15$

$Q_2 = 2.7 \times 43 \times (.35)^{1.5} = 24$

$Q_3 = 2.7 \times 87 \times (.45)^{1.5} = 71$

BY DJA DATE 1/15/79 BERGER ASSOCIATES
CHKD. BY _____ DATE _____
SUBJECT SWEET ARROW LAKE DAM

SHEET NO. 9 OF 15
PROJECT D8470

EMBANKMENT RATING (CONT.)

ELEV 562.9 (CONT): $Q_4 = 2.7 \times 91 \times (.4)^{1.5} = 62$

$$Q_5 = 2.7 \times 62 \times (.35)^{1.5} = 35$$

$$Q = 207$$

ELEV 570: $Q_1 = 2.7 \times 35 \times (3.45)^{1.5} = 606$

$$Q_2 = 2.7 \times 79 \times (7)^{1.5} = 3950$$

$$Q_3 = 2.7 \times 62 \times (7.3)^{1.5} = 3302$$

$$Q_4 = 2.7 \times 43 \times (7.45)^{1.5} = 2361$$

$$Q_5 = 2.7 \times 87 \times (7.55)^{1.5} = 4873$$

$$Q_6 = 2.7 \times 91 \times (7.5)^{1.5} = 5047$$

$$Q_7 = 2.7 \times 62 \times (7.45)^{1.5} = 3404$$

$$Q_8 = 2.7 \times 26 \times (7.2)^{1.5} = 1356$$

$$Q_9 = 2.7 \times 20 \times (3.55)^{1.5} = 361$$

$$Q = 25260 \text{ cfs}$$

ELEV 564: $Q_1 = 2.97 \times 79 \times 1^{1.5} = 235$

$$Q_2 = 2.97 \times 62 \times 1.3^{1.5} = 273$$

$$Q_3 = 2.97 \times 43 \times 1.45^{1.5} = 223$$

$$Q_4 = 2.97 \times 87 \times 1.55^{1.5} = 499$$

$$Q_5 = 2.97 \times 91 \times 1.7^{1.5} = 599$$

$$Q_6 = 2.97 \times 62 \times 1.45^{1.5} = 322$$

$$Q_7 = 2.97 \times 26 \times 1.2^{1.5} = 102$$

$$Q = 2253 \text{ cfs}$$

BY DJR DATE 1/18/79
CHKD. BY _____ DATE _____
SUBJECT SWEET ARROW LAKE DAM

BERGER ASSOCIATES

SHEET NO. 10 OF 11
PROJECT D8490

EMBANKMENT RATING (CONT.) :

ELEV. 566.1 :

$$\begin{aligned}Q_1 &= 2.97 \times 15.2 \times 1.5^{1.5} = 83 \\Q_2 &= 2.97 \times 79 \times 3.05^{1.5} = 1250 \\Q_3 &= 2.97 \times 62 \times 3.35^{1.5} = 1129 \\Q_4 &= 2.97 \times 43 \times 3.5^{1.5} = 836 \\Q_5 &= 2.97 \times 87 \times 3.6^{1.5} = 1765 \\Q_6 &= 2.97 \times 91 \times 3.75^{1.5} = 1963 \\Q_7 &= 2.97 \times 62 \times 3.5^{1.5} = 1206 \\Q_8 &= 2.97 \times 26 \times 3.25^{1.5} = 452 \\Q_9 &= 2.97 \times 9.0 \times 1.6^{1.5} = 54\end{aligned}$$

$$Q = 8738 \text{ cfs}$$

ELEV. 566.5 :

$$\begin{aligned}Q_1 &= 2.97 \times 17.2 \times 1.7^{1.5} = 113 \\Q_2 &= 2.97 \times 79 \times 3.45^{1.5} = 1504 \\Q_3 &= 2.97 \times 62 \times 3.75^{1.5} = 1337 \\Q_4 &= 2.97 \times 43 \times 3.9^{1.5} = 984 \\Q_5 &= 2.97 \times 87 \times 4.0^{1.5} = 2067 \\Q_6 &= 2.97 \times 91 \times 4.15^{1.5} = 2285 \\Q_7 &= 2.97 \times 62 \times 3.9^{1.5} = 1410 \\Q_8 &= 2.97 \times 26 \times 3.65^{1.5} = 538 \\Q_9 &= 2.97 \times 10.2 \times 1.8^{1.5} = 73\end{aligned}$$

$$Q = 10319 \text{ cfs}$$

ELEV. 567 :

$$\begin{aligned}Q_1 &= 2.97 \times 19.8 \times 1.95^{1.5} = 160 \\Q_2 &= 2.97 \times 79 \times 3.95^{1.5} = 1842 \\Q_3 &= 2.97 \times 62 \times 4.25^{1.5} = 1613 \\Q_4 &= 2.97 \times 43 \times 4.4^{1.5} = 1179 \\Q_5 &= 2.97 \times 87 \times 4.5^{1.5} = 2467 \\Q_6 &= 2.97 \times 91 \times 4.65^{1.5} = 2710 \\Q_7 &= 2.97 \times 62 \times 4.4^{1.5} = 1700 \\Q_8 &= 2.97 \times 26 \times 4.15^{1.5} = 653 \\Q_9 &= 2.97 \times 11.5 \times 2.05^{1.5} = 100\end{aligned}$$

$$Q = 12424 \text{ cfs}$$

BY DJR DATE 1/17/79
 CHKD. BY _____ DATE _____
 SUBJECT SWEET ARROW LAKE DAM

BERGER ASSOCIATES

SHEET NO. 11 OF 15
 PROJECT D8490

EMBANKMENT RATING (CONT.)

ELEV. 566

$$\begin{aligned} Q_1 &= 2.97 \times 14.7 \times 1.45^{1.5} = 76 \\ Q_2 &= 2.97 \times 79 \times 3^{1.5} = 1219 \\ Q_3 &= 2.97 \times 62 \times 3.3^{1.5} = 1104 \\ Q_4 &= 2.97 \times 43 \times 3.45^{1.5} = 810 \\ Q_5 &= 2.97 \times 87 \times 3.55^{1.5} = 1728 \\ Q_6 &= 2.97 \times 91 \times 3.7^{1.5} = 1924 \\ Q_7 &= 2.97 \times 62 \times 3.45^{1.5} = 1180 \\ Q_8 &= 2.97 \times 26 \times 3.2^{1.5} = 442 \\ Q_9 &= 2.97 \times 8.7 \times 1.55^{1.5} = 50 \end{aligned}$$

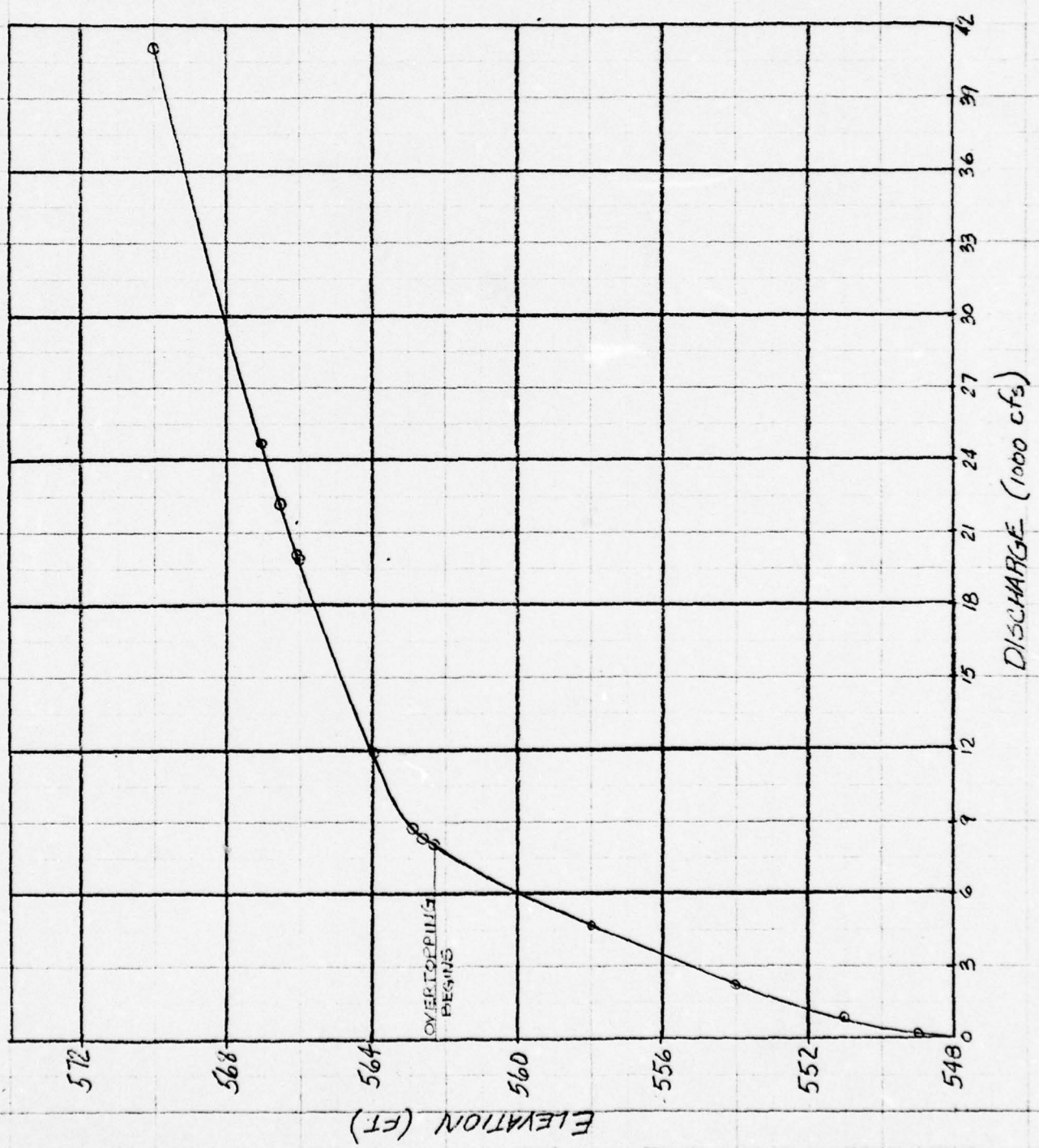
$$Q = 8541 \text{ cfs}$$

Combined Spillway and Embankment Rating

| <u>ELEVATION</u> | <u>DISCHARGE</u> |
|------------------|------------------|
| 548 | 0 |
| 549 | 149 |
| 551 | 772 |
| 554 | 2182 |
| 558 | 4696 |
| 562.3 | 8030 |
| 562.6 | 8310 |
| 562.9 | 8748 |
| 564 | 11757 |
| 566 | 19881 |
| 570 | 40584 |
| 566.1 | 20173 |
| 566.5 | 22135 |
| 567 | 24723 |

BY DJR DATE 1/15/79 BERGER ASSOCIATES
 CHKD. BY _____ DATE _____
 SUBJECT SWEET ARROW LAKE - EMBANKMENT AND SPILLWAY RATING CURVE SHEET NO. 12 OF 15
 PROJECT D8490

EMBANKMENT AND SPILLWAY RATING CURVE:



BY DJR DATE 1/24/79 BERGER ASSOCIATES SHEET NO. 13 OF 15
CHKD. BY _____ DATE _____ PROJECT D8490
SUBJECT SWEET ARROW LAKE DAM

SIZE CLASSIFICATION :

Maximum Storage = 3107 acre-feet

Maximum Height = 35.5 feet

Size Classification is "INTERMEDIATE"

HAZARD CLASSIFICATION :

Several Houses are located near the stream about 2400 feet downstream from the dam where state route 443 crosses the stream. USE HIGH.

RECOMMENDED SPILLWAY DESIGN FLOOD (SDF)

The above classifications indicate use of an SDF equal to the PROBABLE MAXIMUM FLOOD.

BY DJR DATE 1/24/79
CHKD. BY DATE
SUBJECT

BERGER ASSOCIATES

SHEET NO. 14 OF 15
PROJECT D8490

HEC-1 DATA

DRAINAGE AREA = 20.5 SQ. MI.

SUSQUEHANNA BASIN REGION 15B

$C_p = .85$

$C_T = 2.2$

Longest Water Course $L = 10.2$ mi

LENGTH To Centroid $L_{CA} = 5.3$ mi

$$T_p = C_T (L \times L_{CA})^{.3}$$

$T_p = 7.3$ hrs.

RAINFALL (HMR-33)

INDEX = 23.2 in.

Zone 6

Incremental Rainfall

6 hr = 106 %

12 hr = 116 %

24 hr = 125 %

48 hr = 136.5 %

PLANIMETERED AREAS (FROM QUAD SHEETS)

ELEV.: 548 = 92 ACRES

560 = 175 ACRES

580 = 404 ACRES

ZERO STORAGE ELEV.

$$\begin{aligned} \text{ELEV.} &= 548 - (\text{STORAGE} \times 3 / \text{AREA}) \\ &= 512 \end{aligned}$$

BY DJR DATE 1/17/79

BERGER ASSOCIATES

SHEET NO. 15 OF 15

CHKD. BY _____ DATE _____

PROJECT DB490

SUBJECT SWEET ARROW CAPACITY CURVE

SPILLWAY CAPACITY CURVE :

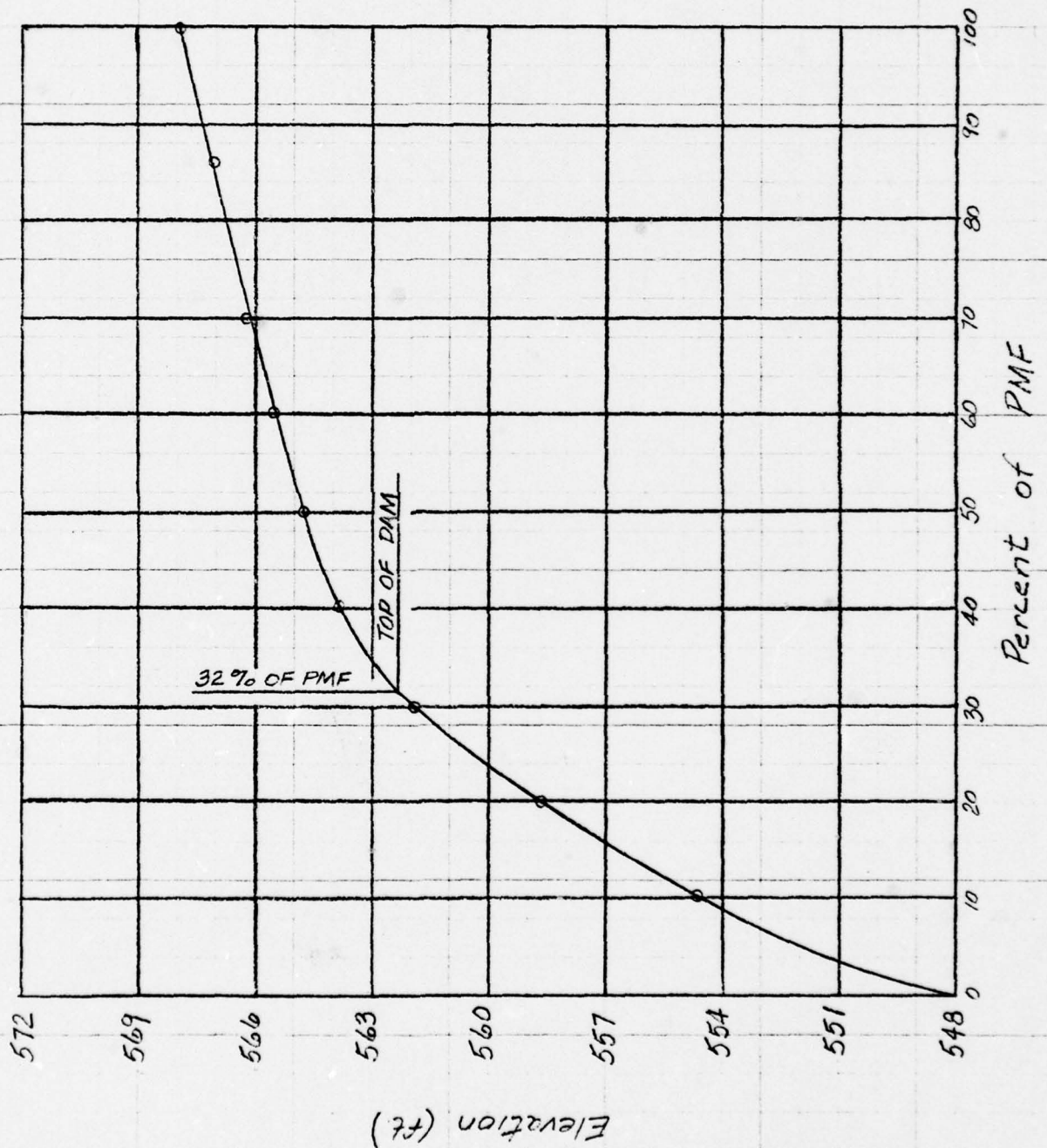


TABLE NO.1

COMPARISON OF WATER SURFACE ELEVATIONS

SWEET ARROW LAKE DAM

PMF = 29,817 cfs

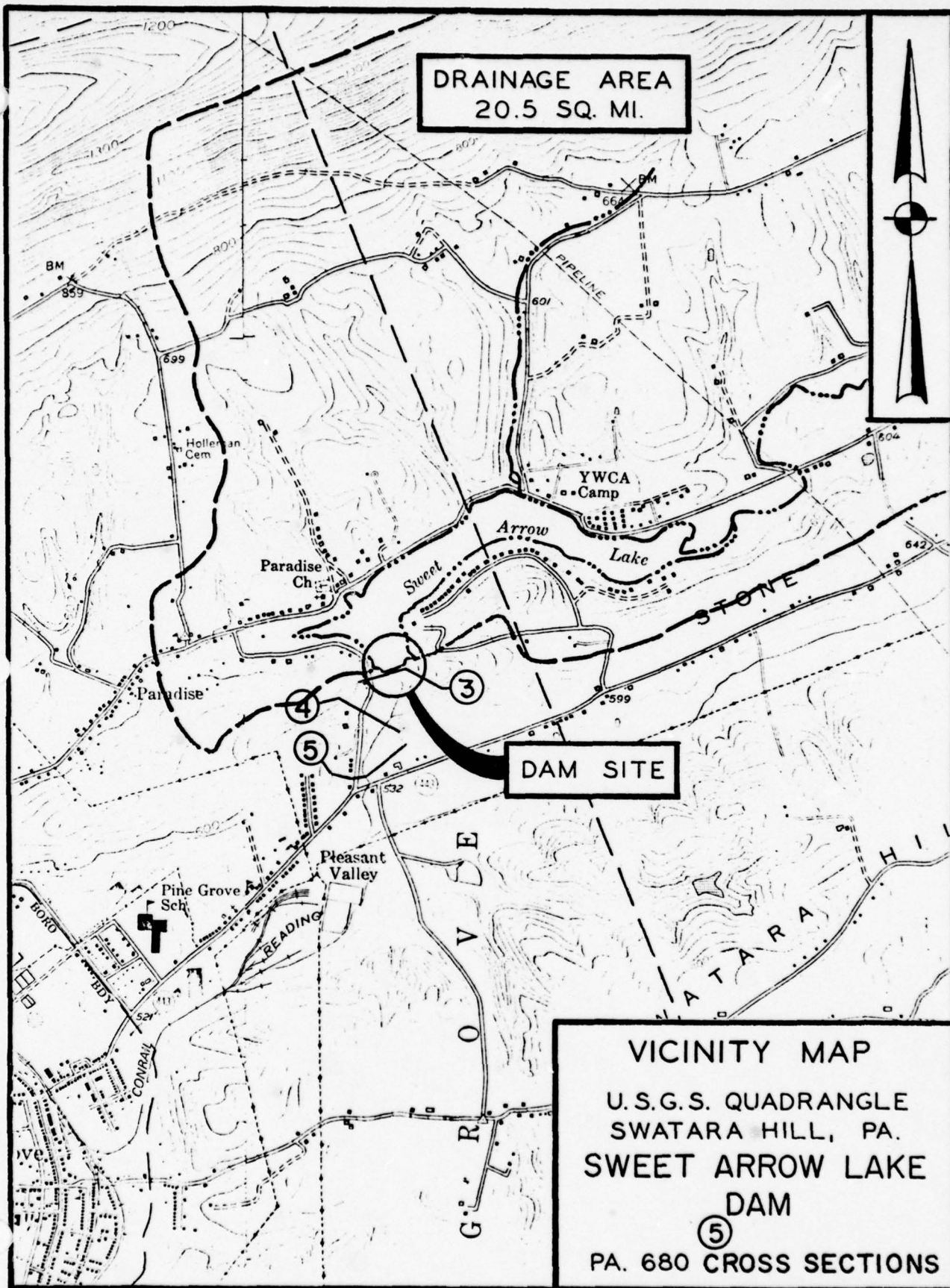
Crest Elevation = 562.5 Low Point = 562.3 Spillway Elevation = 548.0

| <u>STAGE</u> | <u>CREST OF DAM</u> | | <u>2400' D/S OF DAM*</u> <u>APPROX. ELEVATION</u> |
|--|---------------------|--------------|--|
| | <u>ELEVATION</u> | <u>DEPTH</u> | |
| A. At low point in embankment crest | 562.3 | 0 | 533.3 |
| B. 34% Overtopping No Breach | 562.98 | .68 | 533.7 |
| C. 34% PMF Overtopping (15 Minute Breach) | 562.82 | .52 | 542.6 |
| D. 34% PMF Overtopping (2 Hour Breach) | 562.86 | .56 | 539.0 |

*Several Houses located about 2,400 feet downstream of Sweet Arrow Lake Dam.

CONDITION C:

(Time refers to elapsed time after start of storm).
 Time to reach breach elevation 562.8 at dam = 47.5 hours.
 Water level 2,400' downstream just prior to breach = 533.7
 Duration of Breach = 15 Minutes.
 Time for Breach to peak 2,400 feet downstream = .5 Hours.
 Peak elevation 2,400' downstream due to breach = 542.6.
 Rate of increase in water level = 8.9' in one-half hour.



LAST MODIFICATION 21 AUG 78

| | | | | | | | | | | | |
|----|----|---|-------|-------|-------|------|-------|-------|-------|-------|-------|
| 1 | A1 | SWEET ARROW LAKE DAM *** UPPER LITTLE SWATARA CREEK | | | | | | | | | |
| 2 | A2 | PINE GROVE TWP., SCHUYLKILL COUNTY | | | | | | | | | |
| 3 | A3 | NDI # PA-00680 PA DER # 54-102 | | | | | | | | | |
| 4 | B | 300 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | -4 | 0 |
| 5 | B1 | 5 | | | | | | | | | |
| 6 | J | 1 | 9 | 1 | | | | | | | |
| 7 | J1 | 1 | .85 | .7 | .6 | .5 | .4 | .3 | .2 | .1 | |
| 8 | K | 1 | | | | | | 1 | | | |
| 9 | K1 | INFLOW HYDROGRAPH | | | | | | | | | |
| 10 | M | 1 | 1 | 20.5 | | | | | | | |
| 11 | P | | 23.2 | 106 | 116 | 125 | 136.5 | | | | |
| 12 | T | | | | | | | 1 | .05 | | |
| 13 | W | 7.3 | .85 | | | | | | | | |
| 14 | X | -1.5 | -.05 | 2 | | | | | | | |
| 15 | K | 1 | 2 | | | | | 1 | | | |
| 16 | K1 | RESERVOIR ROUTING | | | | | | | | | |
| 17 | Y | | | 1 | 0 | | | | | | |
| 18 | Y1 | 1 | | | | | | 1105 | -1 | | |
| 19 | Y4 | 548 | 549 | 551 | 554 | 558 | 562.3 | 562.6 | 562.9 | 564 | 566 |
| 20 | Y4 | 566.1 | 566.5 | 567 | 570 | | | | | | |
| 21 | Y5 | 0 | 149 | 772 | 2182 | 4696 | 8030 | 8310 | 8748 | 11757 | 19881 |
| 22 | Y5 | 20173 | 22135 | 24723 | 40584 | | | | | | |
| 23 | EA | 0 | 92 | 175 | 404 | | | | | | |
| 24 | EE | 512 | 548 | 560 | 580 | | | | | | |
| 25 | EE | 548 | | | | | | | | | |
| 26 | ED | 562.3 | | | | | | | | | |
| 27 | K | 99 | | | | | | | | | |

1

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 1
ROUTE HYDROGRAPH TO 2
END OF NETWORK

FLOOD HYDROGRAPH PACKAGE (HEC-1)

DAM SAFETY VERSION JULY 1978

LAST MODIFICATION 21 AUG 78

RUN DATE* 79/02/23.

TIME* 08.07.44.

SWEET ARROW LAKE DAM *** UPPER LITTLE SWATARA CREEK
PINE GROVE TWP., SCHUYLKILL COUNTY
NDI # PA-00680 PA DER # 54-102

JOB SPECIFICATION

| | | | | | | | | | |
|-----|-----|------|-------|-----|-------|-------|------|------|-------|
| NO | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
| 300 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | -4 | 0 |
| | | | JOPER | NWT | LROPT | TRACE | | | |
| | | | 5 | 0 | 0 | 0 | | | |

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 9 LRTIO= 1

SWEET ARROW LAKE DAM *** UPPER LITTLE SWATARA CREEK
 PINE GROVE TWP., SCHUYLKILL COUNTY
 NDI # PA-00680 PA DER # 54-102

2/4

JOB SPECIFICATION

| NQ | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|-----|-----|------|-------|-----|-------|-------|------|------|-------|
| 300 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | -4 | 0 |
| | | | JOPER | NWT | LROPT | TRACE | | | |
| | | | 5 | 0 | 0 | 0 | | | |

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 9 LRTIO= 1
 RTIOS= 1.00 .85 .70 .60 .50 .40 .30 .20 .10

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUNG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|-------|------|-------|------|-------|-------|-------|-------|-------|-------|
| 1 | 1 | 20.50 | 0.00 | 20.50 | 0.00 | 0.000 | 0 | 0 | 0 |

PRECIP DATA

| SPFE | PMS | R6 | R12 | R24 | R48 | R72 | R96 |
|------|-------|--------|--------|--------|--------|------|------|
| 0.00 | 23.20 | 106.00 | 116.00 | 125.00 | 136.50 | 0.00 | 0.00 |

TRSPC COMPUTED BY THE PROGRAM IS .824

LOSS DATA

| LROPT | STKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSHX | RTIMP |
|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 1.00 | .05 | 0.00 | 0.00 |

UNIT HYDROGRAPH DATA

TP= 7.30 CP= .85 NTA= 0

RECESSION DATA

STRTO= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 67 END-OF-PERIOD ORDINATES, LAG= 7.22 HOURS, CP= .81 VOL= 1.00

| | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 17. | 62. | 124. | 194. | 269. | 345. | 422. | 498. | 574. | 648. |
| 720. | 791. | 859. | 925. | 990. | 1052. | 1112. | 1171. | 1227. | 1282. |
| 1336. | 1387. | 1436. | 1478. | 1509. | 1530. | 1542. | 1547. | 1546. | 1538. |
| 1525. | 1506. | 1484. | 1457. | 1426. | 1392. | 1353. | 1311. | 1266. | 1216. |
| 1162. | 1102. | 1036. | 962. | 869. | 762. | 660. | 572. | 495. | 429. |
| 371. | 322. | 279. | 241. | 209. | 181. | 157. | 136. | 118. | 102. |
| 88. | 76. | 66. | 57. | 50. | 43. | 37. | | | |

0

END-OF-PERIOD FLOW

| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|-------|-------|--------|------|------|------|--------|-------|-------|--------|------|------|------|--------|
|-------|-------|--------|------|------|------|--------|-------|-------|--------|------|------|------|--------|

SUM 26.09 23.66 2.43 1258242.
 (663.)(601.)(62.)(35629.45)

HYDROGRAPH ROUTING

RESERVOIR ROUTING

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|-------|-------|------|------|-------|------|------|------|
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | 0 |

| NSTPS | NSTD | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|-------|------|-----|-------|-------|-------|-------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 1105. | -1 |

| STAGE | 548.0 | 549.0 | 551.0 | 554.0 | 558.0 | 562.3 | 562.6 | 562.9 | 564.0 | 566.0 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 566.1 | 566.5 | 567.0 | 570.0 | | | | | | |

| FLOW | 0. | 149. | 772. | 2182. | 4696. | 8030. | 8310. | 8748. | 11757. | 19881. |
|------|--------|--------|--------|--------|-------|-------|-------|-------|--------|--------|
| | 20173. | 22135. | 24723. | 40584. | | | | | | |

| SURFACE AREA= | 0. | 92. | 175. | 404. |
|---------------|----|-----|------|------|
| | | | | |

| CAPACITY= | 0. | 1104. | 2680. | 8312. |
|-----------|----|-------|-------|-------|
| | | | | |

| ELEVATION= | 512. | 548. | 560. | 580. |
|------------|------|------|------|------|
| | | | | |

| CREL | SPWID | COBW | EXPW | ELEV | COOL | CAREA | EXPL |
|-------|-------|------|------|------|------|-------|------|
| 548.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COGD | EXPD | DAMWID |
|-------|------|------|--------|
| 562.3 | 0.0 | 0.0 | 0. |

PEAK OUTFLOW IS 29520. AT TIME 46.75 HOURS

PEAK OUTFLOW IS 25108. AT TIME 46.75 HOURS

PEAK OUTFLOW IS 20572. AT TIME 47.00 HOURS

PEAK OUTFLOW IS 17619. AT TIME 47.00 HOURS

PEAK OUTFLOW IS 14600. AT TIME 47.00 HOURS

PEAK OUTFLOW IS 11253. AT TIME 47.75 HOURS

PEAK OUTFLOW IS 7689. AT TIME 48.50 HOURS

PEAK OUTFLOW IS 5128. AT TIME 48.50 HOURS

PEAK OUTFLOW IS 2522. AT TIME 48.75 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

| OPERATION | STATION | AREA | PLAN | RATIOS APPLIED TO FLOWS | | | | | | | | |
|---------------|---------|--------|------|-------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|
| | | | | RATIO 1 | RATIO 2 | RATIO 3 | RATIO 4 | RATIO 5 | RATIO 6 | RATIO 7 | RATIO 8 | RATIO 9 |
| | | | | 1.00 | .85 | .70 | .60 | .50 | .40 | .30 | .20 | .10 |
| HYDROGRAPH AT | 1 | 20.50 | 1 | 29817. | 25345. | 20872. | 17890. | 14909. | 11927. | 8945. | 5963. | 2982. |
| | (| 53.09) | (| 844.33) | (717.68) | (591.03) | (506.60) | (422.17) | (337.73) | (253.30) | (168.87) | (84.43) |
| ROUTED TO | 2 | 20.50 | 1 | 29520. | 25108. | 20572. | 17619. | 14600. | 11253. | 7689. | 5128. | 2522. |
| | (| 53.09) | (| 835.91) | (710.97) | (582.55) | (498.90) | (413.43) | (318.64) | (217.73) | (145.20) | (71.40) |

SUMMARY OF DAM SAFETY ANALYSIS

| PLAN 1 | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|--------------|---------------|----------------|------------|
| ELEVATION | 548.01 | 548.00 | 562.30 |
| STORAGE | 1105. | 1104. | 3107. |
| OUTFLOW | 1. | 0. | 8030. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|--------------|----------------------------|------------------------|-----------------------|---------------------|-------------------------|---------------------------|-----------------------|
| 1.00 | 567.90 | 5.60 | 4365. | 29520. | 11.75 | 46.75 | 0.00 |
| .85 | 567.06 | 4.76 | 4156. | 25108. | 10.75 | 46.75 | 0.00 |
| .70 | 566.18 | 3.88 | 3944. | 20572. | 9.75 | 47.00 | 0.00 |
| .60 | 565.44 | 3.14 | 3773. | 17619. | 9.00 | 47.00 | 0.00 |
| .50 | 564.70 | 2.40 | 3606. | 14600. | 7.75 | 47.00 | 0.00 |
| .40 | 563.82 | 1.52 | 3416. | 11253. | 5.75 | 47.75 | 0.00 |
| .30 | 561.86 | 0.00 | 3021. | 7689. | 0.00 | 48.50 | 0.00 |
| .20 | 558.56 | 0.00 | 2435. | 5128. | 0.00 | 48.50 | 0.00 |
| .10 | 554.54 | 0.00 | 1839. | 2522. | 0.00 | 48.75 | 0.00 |

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 21 AUG 78

EOI ENCOUNTERED.
N>

LAST MODIFICATION 21 AUG 78

| | | | | | | | | | | | |
|----|----|---|-------|-------|-------|------|-------|-------|-------|-------|-------|
| 1 | A1 | SWEET ARROW LAKE DAM *** UPPER LITTLE SWATARA CREEK | | | | | | | | | |
| 2 | A2 | PINE GROVE TWP., SCHUYLKILL COUNTY | | | | | | | | | |
| 3 | A3 | NDI # PA-00680 PA DER # 54-102 | | | | | | | | | |
| 4 | B | 300 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | -4 | 0 |
| 5 | B1 | 5 | | | | | | | | | |
| 6 | J | 1 | 1 | 1 | | | | | | | |
| 7 | J1 | .34 | | | | | | | | | |
| 8 | K | | 1 | | | | | | 1 | | |
| 9 | K1 | INFLOW HYDROGRAPH | | | | | | | | | |
| 10 | M | 1 | 1 | 20.5 | | | | | | | |
| 11 | P | | 23.2 | 106 | 116 | 125 | 136.5 | | | | |
| 12 | Y | | | | | | | 1 | .05 | | |
| 13 | W | 7.3 | .85 | | | | | | | | |
| 14 | X | -1.5 | -.05 | 2 | | | | | | | |
| 15 | K | 1 | 2 | | | | | 1 | | | |
| 16 | K1 | RESERVOIR ROUTING | | | | | | | | | |
| 17 | Y | | | | 1 | 0 | | | | | |
| 18 | Y1 | 1 | | | | | 1105 | -1 | | | |
| 19 | Y4 | 548 | 549 | 551 | 554 | 558 | 562.3 | 562.6 | 562.9 | 564 | 566 |
| 20 | Y4 | 566.1 | 566.5 | 567 | 570 | | | | | | |
| 21 | Y5 | 0 | 149 | 772 | 2182 | 4696 | 8030 | 8310 | 8748 | 11757 | 19881 |
| 22 | Y5 | 20173 | 22135 | 24723 | 40584 | | | | | | |
| 23 | EA | 0 | 92 | 175 | 404 | | | | | | |
| 24 | EA | 512 | 548 | 560 | 580 | | | | | | |
| 25 | EA | 548 | | | | | | | | | |
| 26 | EA | 562.3 | | | | | | | | | |
| 27 | K | 1 | 3 | | | | | 1 | | | |
| 28 | K1 | REACH 2-3 | | | | | | | | | |
| 29 | Y | | | | 1 | 0 | | | | | |
| 30 | Y1 | 1 | | | | | | | | | |
| 31 | Y6 | .1 | .04 | .1 | 525 | 560 | 200 | .01 | | | |
| 32 | Y7 | 0 | 560 | 90 | 540 | 200 | 530 | 205 | 525 | 220 | 525 |
| 33 | Y7 | 225 | 530 | 250 | 540 | 1100 | 560 | | | | |
| 34 | K | 1 | 4 | | | | | 1 | | | |
| 35 | K1 | REACH 3-4 | | | | | | | | | |
| 36 | Y | | | | 1 | 0 | | | | | |
| 37 | Y1 | 1 | | | | | | | | | |
| 38 | Y6 | .1 | .04 | .1 | 523 | 560 | 1200 | .0017 | | | |
| 39 | Y7 | 0 | 560 | 50 | 540 | 100 | 528 | 110 | 523 | 120 | 523 |
| 40 | Y7 | 130 | 528 | 470 | 540 | 630 | 560 | | | | |
| 41 | K | 1 | 5 | | | | | 1 | | | |
| 42 | K1 | REACH 4-5 | | | | | | | | | |
| 43 | Y | | | | 1 | 0 | | | | | |
| 44 | Y1 | 1 | | | | | | | | | |
| 45 | Y6 | .1 | .04 | .1 | 521 | 560 | 1000 | .002 | | | |
| 46 | Y7 | 0 | 560 | 200 | 540 | 450 | 525 | 520 | 521 | 528 | 521 |
| 47 | Y7 | 530 | 525 | 700 | 540 | 830 | 560 | | | | |
| 48 | K | 99 | | | | | | | | | |

1

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

| | |
|----------------------|---|
| RUNOFF HYDROGRAPH AT | 1 |
| ROUTE HYDROGRAPH TO | 2 |
| ROUTE HYDROGRAPH TO | 3 |
| ROUTE HYDROGRAPH TO | 4 |
| ROUTE HYDROGRAPH TO | 5 |
| END OF NETWORK | |

SWEET ARROW LAKE DAM *** UPPER LITTLE SWATARA CREEK
 PINE GROVE TWP., SCHUYLKILL COUNTY
 NDI # PA-00680 PA DER # 54-102

2/7

JOB SPECIFICATION

| | | | | | | | | | |
|-----|-----|------|-------|-----|-------|-------|------|------|-------|
| NQ | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
| 300 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | -4 | 0 |
| | | | JOPER | NWT | LROPT | TRACE | | | |
| | | | 5 | 0 | 0 | 0 | | | |

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= .34

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

| | | | | | | | | |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| ISTAD | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| | | | | | | | | | |
|-------|------|-------|------|-------|-------|-------|-------|-------|-------|
| IHYDG | IUNG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
| 1 | 1 | 20.50 | 0.00 | 20.50 | 0.00 | 0.000 | 0 | 0 | 0 |

PRECIP DATA

| | | | | | | | |
|------|-------|--------|--------|--------|--------|------|------|
| SPFE | PHS | R6 | R12 | R24 | R48 | R72 | R96 |
| 0.00 | 23.20 | 106.00 | 116.00 | 125.00 | 136.50 | 0.00 | 0.00 |

TRSPC COMPUTED BY THE PROGRAM IS .824

LOSS DATA

| | | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| LROPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 1.00 | .05 | 0.00 | 0.00 |

UNIT HYDROGRAPH DATA

TP= 7.30 CP= .85 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 67 END-OF-PERIOD ORDINATES, LAG= 7.22 HOURS, CP= .81 VOL= 1.00

| | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 17. | 62. | 124. | 194. | 269. | 345. | 422. | 498. | 574. | 648. |
| 720. | 791. | 859. | 925. | 990. | 1052. | 1112. | 1171. | 1227. | 1282. |
| 1336. | 1387. | 1436. | 1478. | 1509. | 1530. | 1542. | 1547. | 1546. | 1538. |
| 1525. | 1506. | 1484. | 1457. | 1426. | 1392. | 1353. | 1311. | 1266. | 1216. |
| 1162. | 1102. | 1036. | 962. | 869. | 762. | 660. | 572. | 495. | 429. |
| 371. | 322. | 279. | 241. | 209. | 181. | 157. | 136. | 118. | 102. |
| 88. | 76. | 66. | 57. | 50. | 43. | 37. | | | |

END-OF-PERIOD FLOW

| NO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | NO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|-------|-------|--------|------|------|------|--------|-------|-------|--------|------|------|------|--------|
|-------|-------|--------|------|------|------|--------|-------|-------|--------|------|------|------|--------|

SUM 26.09 23.66 2.43 1258242.
 (663.)(601.)(62.)(35629.45)

HYDROGRAPH ROUTING

RESERVOIR ROUTING

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|-------|-------|------|------|-------|------|------|------|
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | 0 |

| NSTPS | NSTD | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|-------|------|-----|-------|-------|-------|-------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 1105. | -1 |

| STAGE | 548.0 | 549.0 | 551.0 | 554.0 | 558.0 | 562.3 | 562.6 | 562.9 | 564.0 | 566.0 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 566.1 | 566.5 | 567.0 | 570.0 | | | | | | |

| FLOW | 0. | 149. | 772. | 2182. | 4696. | 8030. | 8310. | 8748. | 11757. | 19881. |
|------|--------|--------|--------|--------|-------|-------|-------|-------|--------|--------|
| | 20173. | 22135. | 24723. | 40584. | | | | | | |

SURFACE AREA= 0. 92. 175. 404.

CAPACITY= 0. 1104. 2680. 8312.

ELEVATION= 512. 548. 560. 580.

| CREL | SPWID | COBW | EXPW | ELEV | COOL | CAREA | EXPL |
|-------|-------|------|------|------|------|-------|------|
| 548.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COOD | EXPD | DAMWID |
|-------|------|------|--------|
| 562.3 | 0.0 | 0.0 | 0. |

PEAK OUTFLOW IS 8976. AT TIME 48.25 HOURS

HYDROGRAPH ROUTING

REACH 2-3

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 3 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|-------|-------|------|------|-------|------|------|------|
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | 0 |

| NSTPS | NSTD | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|-------|------|-----|-------|-------|-------|-------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 0. | 0 |

NORMAL DEPTH CHANNEL ROUTING

| QN(1) | QN(2) | QN(3) | ELNVT | ELMAX | RLNTH | SEL |
|-------|-------|-------|-------|-------|-------|--------|
| .1000 | .0400 | .1000 | 525.0 | 560.0 | 200. | .01000 |

HYDROGRAPH ROUTING

REACH 2-3

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 3 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|-------|-------|------|------|-------|------|------|------|
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | 0 |

| NSTPS | NSTD | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|-------|------|-----|-------|-------|-------|-------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 0. | 0 |

NORMAL DEPTH CHANNEL ROUTING

| QN(1) | QN(2) | QN(3) | ELNVT | ELMAX | RLNTH | SEL |
|-------|-------|-------|-------|-------|-------|--------|
| .1000 | .0400 | .1000 | 525.0 | 560.0 | 200. | .01000 |

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

| | | | | | | | | | |
|--------|--------|--------|--------|---------|--------|--------|--------|--------|--------|
| 0.00 | 560.00 | 90.00 | 540.00 | 200.00 | 530.00 | 205.00 | 525.00 | 220.00 | 525.00 |
| 225.00 | 530.00 | 250.00 | 540.00 | 1100.00 | 560.00 | | | | |

| STORAGE | 0. | 0. | 0. | 1. | 1. | 1. | 2. | 3. | 5. | 6. |
|---------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 8. | 12. | 15. | 20. | 25. | 31. | 38. | 45. | 54. | 63. |

| OUTFLOW | 0. | 154. | 498. | 1042. | 1902. | 3099. | 4699. | 6759. | 9333. | 12402. |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|
| | 16620. | 22061. | 28926. | 37413. | 47708. | 59985. | 74411. | 91147. | 110348. | 132163. |

| STAGE | 525.0 | 526.8 | 528.7 | 530.5 | 532.4 | 534.2 | 536.1 | 537.9 | 539.7 | 541.6 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 543.4 | 545.3 | 547.1 | 548.9 | 550.8 | 552.6 | 554.5 | 556.3 | 558.2 | 560.0 |

| FLOW | 0. | 154. | 498. | 1042. | 1902. | 3099. | 4699. | 6759. | 9333. | 12402. |
|------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|
| | 16620. | 22061. | 28926. | 37413. | 47708. | 59985. | 74411. | 91147. | 110348. | 132163. |

MAXIMUM STAGE IS 539.5

HYDROGRAPH ROUTING

REACH 3-4

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 4 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|-------|-------|------|------|-------|------|------|------|
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | 0 |

| NSTPS | NSTD | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|-------|------|-----|-------|-------|-------|-------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 0. | 0 |

HYDROGRAPH ROUTING

REACH 3-4

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 4 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|-------|-------|------|------|-------|------|------|------|
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | 0 |

| NSTPS | NSTD | LAG | AMSK | X | TSK | STORA | ISPRAT |
|-------|------|-----|-------|-------|-------|-------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 0. | 0 |

NORMAL DEPTH CHANNEL ROUTING

| QN(1) | QN(2) | QN(3) | ELNVT | ELMAX | RLNTH | SEL |
|-------|-------|-------|-------|-------|-------|--------|
| .1000 | .0400 | .1000 | 523.0 | 560.0 | 1200. | .00170 |

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

| | | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0.00 | 560.00 | 50.00 | 540.00 | 100.00 | 528.00 | 110.00 | 523.00 | 120.00 | 523.00 |
| 130.00 | 528.00 | 470.00 | 540.00 | 630.00 | 560.00 | | | | |

| | 0. | 1. | 2. | 4. | 9. | 17. | 28. | 43. | 62. | 83 |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
| STORAGE | 107. | 131. | 157. | 183. | 211. | 240. | 270. | 301. | 333. | 366 |
| OUTFLOW | 0. | 53. | 197. | 478. | 994. | 1819. | 3034. | 4708. | 6908. | 9785 |
| | 13508. | 17806. | 22669. | 28093. | 34079. | 40629. | 47744. | 55432. | 63697. | 72545 |
| STAGE | 523.0 | 524.9 | 526.9 | 528.8 | 530.8 | 532.7 | 534.7 | 536.6 | 538.6 | 540. |
| | 542.5 | 544.4 | 546.4 | 548.3 | 550.3 | 552.2 | 554.2 | 556.1 | 558.1 | 560. |
| FLOW | 0. | 53. | 197. | 478. | 994. | 1819. | 3034. | 4708. | 6908. | 9785 |
| | 13508. | 17806. | 22669. | 28093. | 34079. | 40629. | 47744. | 55432. | 63697. | 72545 |

MAXIMUM STAGE IS 540.0

HYDROGRAPH ROUTING

REACH 4-5

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|-------|-------|------|------|-------|------|------|------|
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | 0 |

| NSTPS | NSTD | LAG | AMSK | X | TSK | STORA | ISPRAT |
|-------|------|-----|-------|-------|-------|-------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 0. | 0 |

08
6/7

HYDROGRAPH ROUTING

REACH 4-5

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRIS | ISAME | IOPT | IPMP | LSTR |
|-------|-------|------|------|-------|------|------|------|
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | 0 |

| NSTPS | NSTD | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|-------|------|-----|-------|-------|-------|-------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 0. | 0 |

NORMAL DEPTH CHANNEL ROUTING

| QN(1) | QN(2) | QN(3) | ELNVT | ELMAX | RLNTH | SEL |
|-------|-------|-------|-------|-------|-------|--------|
| .1000 | .0400 | .1000 | 521.0 | 560.0 | 1000. | .00200 |

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

| | | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0.00 | 560.00 | 200.00 | 540.00 | 450.00 | 525.00 | 520.00 | 521.00 | 528.00 | 521.00 |
| 530.00 | 525.00 | 700.00 | 540.00 | 830.00 | 560.00 | | | | |

| | | | | | | | | | | |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|
| STORAGE | 0. | 1. | 4. | 10. | 17. | 28. | 42. | 58. | 76. | 98. |
| | 122. | 147. | 175. | 203. | 234. | 266. | 299. | 334. | 371. | 409. |
| OUTFLOW | 0. | 101. | 525. | 1563. | 3157. | 5368. | 8251. | 11863. | 16261. | 21497. |
| | 27832. | 35113. | 43270. | 52319. | 62274. | 73152. | 84972. | 97754. | 111515. | 126276. |
| STAGE | 521.0 | 523.1 | 525.1 | 527.2 | 529.2 | 531.3 | 533.3 | 535.4 | 537.4 | 539.5 |
| | 541.5 | 543.6 | 545.6 | 547.7 | 549.7 | 551.8 | 553.8 | 555.9 | 557.9 | 560.0 |
| FLOW | 0. | 101. | 525. | 1563. | 3157. | 5368. | 8251. | 11863. | 16261. | 21497. |
| | 27832. | 35113. | 43270. | 52319. | 62274. | 73152. | 84972. | 97754. | 111515. | 126276. |

MAXIMUM STAGE IS 533.7

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

| OPERATION | STATION | AREA | PLAN | RATIO | 1 |
|-----------|---------|------|------|-------|-----|
| | | | | | .34 |

| | | | | |
|---------------|---|-------|---|--------|
| HYDROGRAPH AT | 1 | 20.50 | 1 | 10179. |
|---------------|---|-------|---|--------|

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OB
7/7

RATIOS APPLIED TO FLOWS

| OPERATION | STATION | AREA | PLAN | RATIO | 1 |
|---------------|---------|--------|------|---------|-----|
| | | | | | .34 |
| HYDROGRAPH AT | 1 | 20.50 | 1 | 10138. | |
| | (| 53.09) | (| 287.07) | (|
| ROUTED TO | 2 | 20.50 | 1 | 8976. | |
| | (| 53.09) | (| 254.17) | (|
| ROUTED TO | 3 | 20.50 | 1 | 8977. | |
| | (| 53.09) | (| 254.21) | (|
| ROUTED TO | 4 | 20.50 | 1 | 8965. | |
| | (| 53.09) | (| 253.86) | (|
| ROUTED TO | 5 | 20.50 | 1 | 8971. | |
| | (| 53.09) | (| 254.02) | (|

1

SUMMARY OF DAM SAFETY ANALYSIS

| PLAN 1 | ELEVATION | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|--------------|-----------|---------------|----------------|------------|
| | 548.01 | 548.00 | 562.30 | |
| STORAGE | 1105. | 1104. | 3107. | |
| OUTFLOW | 1. | 0. | 8030. | |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|--------------|----------------------------|------------------------|-----------------------|---------------------|-------------------------|---------------------------|-----------------------|
| .34 | 562.98 | .68 | 3243. | 8976. | 3.50 | 48.25 | 0.00 |

PLAN 1 STATION 3

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------|-------------------|-------------------|------------|
| .34 | 8977. | 539.5 | 48.25 |

PLAN 1 STATION 4

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------|-------------------|-------------------|------------|
| .34 | 8965. | 540.0 | 48.50 |

PLAN 1 STATION 5

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------|-------------------|-------------------|------------|
| .34 | 8971. | 537.7 | 48.50 |

LAST MODIFICATION 21 AUG 78

BREACH ANALYSIS

1/20

| | | | | | | | | | | | |
|----|-----|--|-------|-------|-------|------|-------|-------|-------|-------|-------|
| 1 | A1 | SWEET ARROW LAKE DAM **** UPPER LITTLE SWATARA CREEK | | | | | | | | | |
| 2 | A2 | PINE GROVE TWP., SCHUYLKILL COUNTY | | | | | | | | | |
| 3 | A3 | NDI # PA-00680 PA DER # 54-102 | | | | | | | | | |
| 4 | B | 300 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | -4 | 0 |
| 5 | B1 | 5 | | | | | | | | | |
| 6 | J | 5 | 1 | 1 | | | | | | | |
| 7 | J1 | .34 | | | | | | | | | |
| 8 | K | | 1 | | | | | 1 | | | |
| 9 | K1 | INFLOW HYDROGRAPH | | | | | | | | | |
| 10 | M | 1 | 1 | 20.5 | | | | | | 1 | |
| 11 | P | | 23.2 | 106 | 116 | 125 | 136.5 | | | | |
| 12 | T | | | | | | | 1 | .05 | | |
| 13 | W | 7.3 | .85 | | | | | | | | |
| 14 | X | -1.5 | -.05 | 2 | | | | | | | |
| 15 | K | 1 | 2 | | | | | 1 | | | |
| 16 | K1 | RESERVOIR ROUTING - DAM BREACH | | | | | | | | | |
| 17 | Y | | | 1 | 1 | | | | | | |
| 18 | Y1 | 1 | | | | | 1105 | -1 | | | |
| 19 | Y4 | 548 | 549 | 551 | 554 | 558 | 562.3 | 562.6 | 562.9 | 564 | 566 |
| 20 | Y4 | 566.1 | 566.5 | 567 | 570 | | | | | | |
| 21 | Y5 | 0 | 149 | 772 | 2182 | 4696 | 8030 | 8310 | 8748 | 11757 | 19881 |
| 22 | Y5 | 20173 | 22135 | 24723 | 40584 | | | | | | |
| 23 | \$A | 0 | 92 | 175 | 404 | | | | | | |
| 24 | \$E | 512 | 548 | 560 | 580 | | | | | | |
| 25 | \$F | 548 | | | | | | | | | |
| 26 | \$D | 562.3 | | | | | | | | | |
| 27 | \$B | 50 | 1 | 538 | .25 | 548 | 562.8 | | | | |
| 28 | \$B | 50 | 1 | 538 | .5 | 548 | 562.8 | | | | |
| 29 | \$B | 50 | 1 | 538 | 1 | 548 | 562.8 | | | | |
| 30 | \$B | 50 | 1 | 538 | 2 | 548 | 562.8 | | | | |
| 31 | \$B | 50 | 1 | 538 | 4 | 548 | 562.8 | | | | |
| 32 | K | 1 | 3 | | | | | 1 | | | |
| 33 | K1 | REACH 2-3 | | | | | | | | | |
| 34 | Y | | | 1 | 1 | | | | | | |
| 35 | Y1 | 1 | | | | | | | | | |
| 36 | Y6 | .1 | .04 | .1 | 525 | 560 | 200 | .01 | | | |
| 37 | Y7 | 0 | 560 | 90 | 540 | 200 | 530 | 205 | 525 | 220 | 525 |
| 38 | Y7 | 225 | 530 | 250 | 540 | 1100 | 560 | | | | |
| 39 | K | 1 | 4 | | | | | 1 | | | |
| 40 | K1 | REACH 3-4 | | | | | | | | | |
| 41 | Y | | | 1 | 1 | | | | | | |
| 42 | Y1 | 1 | | | | | | | | | |
| 43 | Y6 | .1 | .04 | .1 | 523 | 560 | 1200 | .0017 | | | |
| 44 | Y7 | 0 | 560 | 50 | 540 | 100 | 528 | 110 | 523 | 120 | 523 |
| 45 | Y7 | 130 | 528 | 470 | 540 | 630 | 560 | | | | |
| 46 | K | 1 | 5 | | | | | 1 | | | |
| 47 | K1 | REACH 4-5 | | | | | | | | | |
| 48 | Y | | | 1 | 1 | | | | | | |
| 49 | Y1 | 1 | | | | | | | | | |
| 50 | Y6 | .1 | .04 | .1 | 521 | 560 | 1000 | .002 | | | |
| 51 | Y7 | 0 | 560 | 200 | 540 | 450 | 525 | 520 | 521 | 528 | 521 |
| 52 | Y7 | 530 | 525 | 700 | 540 | 830 | 560 | | | | |
| 53 | K | 99 | | | | | | | | | |

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

| | |
|----------------------|---|
| RUNOFF HYDROGRAPH AT | 1 |
| ROUTE HYDROGRAPH TO | 2 |
| ROUTE HYDROGRAPH TO | 3 |
| ROUTE HYDROGRAPH TO | 4 |
| ROUTE HYDROGRAPH TO | 5 |

SWEET ARROW LAKE DAM *** UPPER LITTLE SWATARA CREEK
PINE GROVE TWP., SCHUYLKILL COUNTY
NDI # PA-00680 PA DER # 54-102

B
2/20

JOB SPECIFICATION

| NQ | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|-----|-----|------|-------|-----|-------|-------|------|------|-------|
| 300 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | -4 | 0 |
| | | | JOPER | NWT | LROPT | TRACE | | | |
| | | | 5 | 0 | 0 | 0 | | | |

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 5 NRTIO= 1 LRTIO= 1
RTIOS= .34

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUNG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|-------|------|-------|------|-------|-------|-------|-------|-------|-------|
| 1 | 1 | 20.50 | 0.00 | 20.50 | 0.00 | 0.000 | 0 | 1 | 0 |

PRECIP DATA

| SPFE | PMS | R6 | R12 | R24 | R48 | R72 | R96 |
|------|-------|--------|--------|--------|--------|------|------|
| 0.00 | 23.20 | 106.00 | 116.00 | 125.00 | 136.50 | 0.00 | 0.00 |

TRSPC COMPUTED BY THE PROGRAM IS .824

LOSS DATA

| LROPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 1.00 | .05 | 0.00 | 0.00 |

UNIT HYDROGRAPH DATA

TP= 7.30 CP= .85 NTA= 0

RECESSION DATA

STRTQ= -1.50 ORCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 67 END-OF-PERIOD ORDINATES, LAG= 7.22 HOURS, CP= .81 VOL= 1.00

| | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 17. | 62. | 124. | 194. | 269. | 345. | 422. | 498. | 574. | 648. |
| 720. | 791. | 859. | 925. | 990. | 1052. | 1112. | 1171. | 1227. | 1282. |
| 1336. | 1387. | 1436. | 1478. | 1509. | 1530. | 1542. | 1547. | 1546. | 1538. |
| 1525. | 1506. | 1484. | 1457. | 1426. | 1392. | 1353. | 1311. | 1266. | 1216. |
| 1162. | 1102. | 1036. | 962. | 869. | 762. | 660. | 572. | 495. | 429. |
| 371. | 322. | 279. | 241. | 209. | 181. | 157. | 136. | 118. | 102. |
| 88. | 76. | 66. | 57. | 50. | 43. | 37. | | | |

0

END-OF-PERIOD FLOW

| NO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | NO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|-------|-------|--------|------|------|------|--------|-------|-------|--------|------|------|------|--------|
|-------|-------|--------|------|------|------|--------|-------|-------|--------|------|------|------|--------|

SUM 26.09 23.66 2.43 1258242.
(663.)(601.)(62.)(35629.45)

B
3/20

HYDROGRAPH ROUTING

RESERVOIR ROUTING - DAM BREACH

| ISTAD | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ALL PLANS HAVE SAME ROUTING DATA

| GLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|-------|-------|------|------|-------|------|------|------|
| 0.0 | 0.000 | 0.00 | 1 | 1 | 0 | 0 | 0 |

| NSTPS | NSTDL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|-------|-------|-----|-------|-------|-------|-------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 1105. | -1 |

| STAGE | 548.0 | 549.0 | 551.0 | 554.0 | 558.0 | 562.3 | 562.6 | 562.9 | 564.0 | 566.0 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 566.1 | 566.5 | 567.0 | 570.0 | | | | | | |

| FLOW | 0. | 149. | 772. | 2182. | 4696. | 8030. | 8310. | 8748. | 11757. | 19881. |
|------|--------|--------|--------|--------|-------|-------|-------|-------|--------|--------|
| | 20173. | 22135. | 24723. | 40584. | | | | | | |

| SURFACE AREA= | 0. | 92. | 175. | 404. |
|---------------|----|-----|------|------|
|---------------|----|-----|------|------|

| CAPACITY= | 0. | 1104. | 2680. | 8312. |
|-----------|----|-------|-------|-------|
|-----------|----|-------|-------|-------|

| ELEVATION= | 512. | 548. | 560. | 580. |
|------------|------|------|------|------|
|------------|------|------|------|------|

| CREL | SPWID | COBW | EXPW | ELEVL | COOL | CAREA | EXPL |
|-------|-------|------|------|-------|------|-------|------|
| 548.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COOD | EXPD | DAMWID |
|-------|------|------|--------|
| 562.3 | 0.0 | 0.0 | 0. |

DAM BREACH DATA

| BRWID | Z | ELBM | TFAIL | WSEL | FAILEL |
|-------|------|--------|-------|--------|--------|
| 50. | 1.00 | 538.00 | .25 | 548.00 | 562.80 |

BEGIN DAM FAILURE AT 47.50 HOURS

PEAK OUTFLOW IS 32629. AT TIME 47.75 HOURS

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .005 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .250 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

| TIME (HOURS) | TIME FROM | | COMPUTED | | ERROR (CFS) | ACCUMULATED ERROR (CFS) | ACCUMULATED ERROR (AC-FT) |
|-----------------|-----------------------------------|-------------------------------|-------------------------------|---|----------------|-------------------------------|---------------------------------|
| | BEGINNING OF BREACH (HOURS) | BREACH HYDROGRAPH (CFS) | BREACH HYDROGRAPH (CFS) | = | | | |
| 47.500 | 0.000 | 8624. | 8624. | | 0. | 0. | 0. |
| 47.505 | .005 | 9104. | 8784. | | 320. | 320. | 0. |
| 47.510 | .010 | 9584. | 8916. | | 668. | 988. | 0. |
| 47.515 | .015 | 10064. | 9073. | | 991. | 1979. | 1. |
| 47.520 | .020 | 10544. | 9252. | | 1292. | 3272. | 1. |
| 47.525 | .025 | 11025. | 9452. | | 1573. | 4845. | 2. |
| 47.530 | .030 | 11505. | 9670. | | 1835. | 6680. | 3. |
| 47.535 | .035 | 11985. | 9895. | | 2125. | 8805. | 4. |

4/20

| TIME (HOURS) | BEGINNING OF BREACH (HOURS) | BREACH HYDROGRAPH (CFS) | BREACH HYDROGRAPH (CFS) | ERROR (CFS) | ACCUMULATED ERROR (CFS) | ACCUMULATED ERROR (AC-FT) |
|-----------------|-----------------------------------|-------------------------------|-------------------------------|----------------|-------------------------------|---------------------------------|
| 47.500 | 0.000 | 8624. | 8624. | 0. | 0. | 0. |
| 47.505 | .005 | 9104. | 8784. | 320. | 320. | 0. |
| 47.510 | .010 | 9584. | 8916. | 668. | 988. | 0. |
| 47.515 | .015 | 10064. | 9073. | 991. | 1979. | 1. |
| 47.520 | .020 | 10544. | 9252. | 1292. | 3272. | 1. |
| 47.525 | .025 | 11025. | 9452. | 1573. | 4845. | 2. |
| 47.530 | .030 | 11505. | 9670. | 1835. | 6680. | 3. |
| 47.535 | .035 | 11985. | 9905. | 2079. | 8759. | 4. |
| 47.540 | .040 | 12465. | 10158. | 2307. | 11066. | 5. |
| 47.545 | .045 | 12945. | 10428. | 2517. | 13583. | 6. |
| 47.550 | .050 | 13425. | 10713. | 2712. | 16296. | 7. |
| 47.555 | .055 | 13905. | 11013. | 2892. | 19188. | 8. |
| 47.560 | .060 | 14385. | 11329. | 3057. | 22244. | 9. |
| 47.565 | .065 | 14865. | 11659. | 3207. | 25451. | 11. |
| 47.570 | .070 | 15345. | 12003. | 3342. | 28794. | 12. |
| 47.575 | .075 | 15826. | 12361. | 3464. | 32258. | 13. |
| 47.580 | .080 | 16306. | 12733. | 3572. | 35830. | 15. |
| 47.585 | .085 | 16786. | 13119. | 3667. | 39497. | 16. |
| 47.590 | .090 | 17266. | 13518. | 3748. | 43245. | 18. |
| 47.595 | .095 | 17746. | 13930. | 3816. | 47061. | 19. |
| 47.600 | .100 | 18226. | 14355. | 3871. | 50932. | 21. |
| 47.605 | .105 | 18706. | 14792. | 3914. | 54846. | 23. |
| 47.610 | .110 | 19186. | 15242. | 3944. | 58790. | 24. |
| 47.615 | .115 | 19666. | 15705. | 3962. | 62751. | 26. |
| 47.620 | .120 | 20146. | 16179. | 3967. | 66718. | 28. |
| 47.625 | .125 | 20627. | 16666. | 3961. | 70679. | 29. |
| 47.630 | .130 | 21107. | 17164. | 3943. | 74622. | 31. |
| 47.635 | .135 | 21587. | 17674. | 3913. | 78535. | 32. |
| 47.640 | .140 | 22067. | 18195. | 3871. | 82406. | 34. |
| 47.645 | .145 | 22547. | 18728. | 3819. | 86225. | 36. |
| 47.650 | .150 | 23027. | 19272. | 3755. | 89979. | 37. |
| 47.655 | .155 | 23507. | 19830. | 3677. | 93656. | 39. |
| 47.660 | .160 | 23987. | 20408. | 3579. | 97236. | 40. |
| 47.665 | .165 | 24467. | 20996. | 3471. | 100707. | 42. |
| 47.670 | .170 | 24947. | 21596. | 3351. | 104058. | 43. |
| 47.675 | .175 | 25428. | 22207. | 3221. | 107279. | 44. |
| 47.680 | .180 | 25908. | 22828. | 3079. | 110358. | 46. |
| 47.685 | .185 | 26388. | 23460. | 2927. | 113285. | 47. |
| 47.690 | .190 | 26868. | 24103. | 2765. | 116050. | 48. |
| 47.695 | .195 | 27348. | 24756. | 2592. | 118642. | 49. |
| 47.700 | .200 | 27828. | 25419. | 2409. | 121050. | 50. |
| 47.705 | .205 | 28308. | 26093. | 2216. | 123266. | 51. |
| 47.710 | .210 | 28788. | 26779. | 2009. | 125275. | 52. |
| 47.715 | .215 | 29268. | 27477. | 1791. | 127066. | 53. |
| 47.720 | .220 | 29748. | 28186. | 1583. | 128629. | 53. |
| 47.725 | .225 | 30229. | 28903. | 1325. | 129954. | 54. |
| 47.730 | .230 | 30709. | 29631. | 1078. | 131032. | 54. |
| 47.735 | .235 | 31189. | 30367. | 822. | 131854. | 54. |
| 47.740 | .240 | 31669. | 31112. | 557. | 132411. | 55. |
| 47.745 | .245 | 32149. | 31866. | 283. | 132694. | 55. |
| 47.750 | .250 | 32629. | 32629. | 0. | 132694. | 55. |

1#OVF#

STATION 2

TIME
(HRS)

(O) INTERPOLATED BREACH HYDROGRAPH
(B) COMPUTED BREACH HYDROGRAPH

5/20

TIME

(O) INTERPOLATED BREACH HYDROGRAPH

(B) COMPUTED BREACH HYDROGRAPH

(HRS)

8000. 12000. 16000. 20000. 24000. 28000. 32000. 36000. 0. 0. 0. 0.

| | | | | | | | | | | | |
|-------|---------|---|---|---|---|---|---|---|---|---|---|
| 47.50 | 1. B | . | . | . | . | . | . | . | . | . | . |
| 47.51 | 2. BO | . | . | . | . | . | . | . | . | . | . |
| 47.51 | 3. B O | . | . | . | . | . | . | . | . | . | . |
| 47.52 | 4. B O | . | . | . | . | . | . | . | . | . | . |
| 47.52 | 5. B O | . | . | . | . | . | . | . | . | . | . |
| 47.53 | 6. B O | . | . | . | . | . | . | . | . | . | . |
| 47.53 | 7. B O | . | . | . | . | . | . | . | . | . | . |
| 47.54 | 8. B O | . | . | . | . | . | . | . | . | . | . |
| 47.54 | 9. B O | . | . | . | . | . | . | . | . | . | . |
| 47.55 | 10. B O | . | . | . | . | . | . | . | . | . | . |
| 47.55 | 11. B O | . | . | . | . | . | . | . | . | . | . |
| 47.56 | 12. B O | . | . | . | . | . | . | . | . | . | . |
| 47.56 | 13. B O | . | . | . | . | . | . | . | . | . | . |
| 47.57 | 14. B O | . | . | . | . | . | . | . | . | . | . |
| 47.57 | 15. B O | . | . | . | . | . | . | . | . | . | . |
| 47.58 | 16. B O | . | . | . | . | . | . | . | . | . | . |
| 47.58 | 17. B O | . | . | . | . | . | . | . | . | . | . |
| 47.59 | 18. B O | . | . | . | . | . | . | . | . | . | . |
| 47.59 | 19. B O | . | . | . | . | . | . | . | . | . | . |
| 47.60 | 20. B O | . | . | . | . | . | . | . | . | . | . |
| 47.60 | 21. B O | . | . | . | . | . | . | . | . | . | . |
| 47.61 | 22. B O | . | . | . | . | . | . | . | . | . | . |
| 47.61 | 23. B O | . | . | . | . | . | . | . | . | . | . |
| 47.62 | 24. B O | . | . | . | . | . | . | . | . | . | . |
| 47.62 | 25. B O | . | . | . | . | . | . | . | . | . | . |
| 47.63 | 26. B O | . | . | . | . | . | . | . | . | . | . |
| 47.63 | 27. B O | . | . | . | . | . | . | . | . | . | . |
| 47.64 | 28. B O | . | . | . | . | . | . | . | . | . | . |
| 47.64 | 29. B O | . | . | . | . | . | . | . | . | . | . |
| 47.65 | 30. B O | . | . | . | . | . | . | . | . | . | . |
| 47.65 | 31. B O | . | . | . | . | . | . | . | . | . | . |
| 47.66 | 32. B O | . | . | . | . | . | . | . | . | . | . |
| 47.66 | 33. B O | . | . | . | . | . | . | . | . | . | . |
| 47.67 | 34. B O | . | . | . | . | . | . | . | . | . | . |
| 47.67 | 35. B O | . | . | . | . | . | . | . | . | . | . |
| 47.68 | 36. B O | . | . | . | . | . | . | . | . | . | . |
| 47.68 | 37. B O | . | . | . | . | . | . | . | . | . | . |
| 47.69 | 38. B O | . | . | . | . | . | . | . | . | . | . |
| 47.69 | 39. B O | . | . | . | . | . | . | . | . | . | . |
| 47.70 | 40. B O | . | . | . | . | . | . | . | . | . | . |
| 47.70 | 41. B O | . | . | . | . | . | . | . | . | . | . |
| 47.71 | 42. B O | . | . | . | . | . | . | . | . | . | . |
| 47.71 | 43. B O | . | . | . | . | . | . | . | . | . | . |
| 47.72 | 44. B O | . | . | . | . | . | . | . | . | . | . |
| 47.72 | 45. B O | . | . | . | . | . | . | . | . | . | . |
| 47.73 | 46. B O | . | . | . | . | . | . | . | . | . | . |
| 47.73 | 47. B O | . | . | . | . | . | . | . | . | . | . |
| 47.74 | 48. B O | . | . | . | . | . | . | . | . | . | . |
| 47.74 | 49. B O | . | . | . | . | . | . | . | . | . | . |
| 47.75 | 50. B | . | . | . | . | . | . | . | . | . | . |
| 47.75 | 51. B | . | . | . | . | . | . | . | . | . | . |

B
6/20

DAM BREACH DATA

| BRWID | Z | ELBM | TFAIL | WSEL | FAILEL |
|-------|------|--------|-------|--------|--------|
| 50. | 1.00 | 538.00 | .50 | 548.00 | 562.80 |

BEGIN DAM FAILURE AT 47.50 HOURS

PEAK OUTFLOW IS 30491. AT TIME 48.00 HOURS

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .010 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .250 HOURS.

THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.

INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

| TIME (HOURS) | TIME FROM BEGINNING OF BREACH (HOURS) | INTERPOLATED BREACH HYDROGRAPH (CFS) | COMPUTED BREACH HYDROGRAPH (CFS) | = ERROR (CFS) | ACCUMULATED ERROR (CFS) | ACCUMULATED ERROR (AC-FT) |
|-----------------|--|---|---|------------------|-------------------------------|---------------------------------|
| 47.500 | 0.000 | 8624. | 8624. | 0. | 0. | 0. |
| 47.510 | .010 | 8934. | 8787. | 147. | 147. | 0. |
| 47.520 | .020 | 9245. | 8923. | 322. | 469. | 0. |
| 47.530 | .030 | 9555. | 9082. | 473. | 942. | 1. |
| 47.540 | .040 | 9865. | 9263. | 602. | 1544. | 1. |
| 47.550 | .050 | 10176. | 9464. | 712. | 2255. | 2. |
| 47.560 | .060 | 10486. | 9682. | 804. | 3059. | 3. |
| 47.570 | .070 | 10796. | 9918. | 879. | 3938. | 3. |
| 47.580 | .080 | 11107. | 10169. | 938. | 4875. | 4. |
| 47.590 | .090 | 11417. | 10436. | 981. | 5857. | 5. |
| 47.600 | .100 | 11727. | 10717. | 1011. | 6867. | 6. |
| 47.610 | .110 | 12038. | 11012. | 1026. | 7893. | 7. |
| 47.620 | .120 | 12348. | 11320. | 1028. | 8921. | 7. |
| 47.630 | .130 | 12658. | 11641. | 1017. | 9938. | 8. |
| 47.640 | .140 | 12969. | 11975. | 993. | 10932. | 9. |
| 47.650 | .150 | 13279. | 12321. | 958. | 11889. | 10. |
| 47.660 | .160 | 13589. | 12679. | 910. | 12799. | 11. |
| 47.670 | .170 | 13900. | 13049. | 851. | 13650. | 11. |
| 47.680 | .180 | 14210. | 13429. | 781. | 14431. | 12. |
| 47.690 | .190 | 14520. | 13820. | 700. | 15131. | 13. |
| 47.700 | .200 | 14831. | 14222. | 609. | 15740. | 13. |
| 47.710 | .210 | 15141. | 14633. | 508. | 16248. | 13. |
| 47.720 | .220 | 15451. | 15055. | 397. | 16645. | 14. |
| 47.730 | .230 | 15762. | 15486. | 276. | 16920. | 14. |
| 47.740 | .240 | 16072. | 15926. | 146. | 17066. | 14. |
| 47.750 | .250 | 16382. | 16382. | 0. | 17066. | 14. |
| 47.760 | .260 | 16947. | 16855. | 91. | 17158. | 14. |
| 47.770 | .270 | 17511. | 17338. | 173. | 17331. | 14. |
| 47.780 | .280 | 18075. | 17829. | 246. | 17577. | 15. |
| 47.790 | .290 | 18640. | 18329. | 310. | 17887. | 15. |
| 47.800 | .300 | 19204. | 18838. | 366. | 18253. | 15. |
| 47.810 | .310 | 19768. | 19355. | 414. | 18666. | 15. |
| 47.820 | .320 | 20333. | 19879. | 453. | 19120. | 16. |
| 47.830 | .330 | 20897. | 20413. | 484. | 19604. | 16. |
| 47.840 | .340 | 21461. | 20960. | 501. | 20105. | 17. |
| 47.850 | .350 | 22026. | 21514. | 512. | 20617. | 17. |
| 47.860 | .360 | 22590. | 22075. | 515. | 21131. | 17. |
| 47.870 | .370 | 23154. | 22643. | 511. | 21643. | 18. |
| 47.880 | .380 | 23719. | 23217. | 501. | 22144. | 18. |
| 47.890 | .390 | 24283. | 23798. | 485. | 22630. | 19. |
| 47.900 | .400 | 24847. | 24384. | 464. | 23093. | 19. |
| 47.910 | .410 | 25412. | 24975. | 436. | 23530. | 19. |
| 47.920 | .420 | 25976. | 25572. | 404. | 23934. | 20. |
| 47.930 | .430 | 26541. | 26174. | 367. | 24300. | 20. |

B
7/20

| TIME (HRS) | (O) INTERPOLATED BREACH HYDROGRAPH | | | | | | | | | | | |
|---------------|------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| | 8000. | 10000. | 12000. | 14000. | 16000. | 18000. | 20000. | 22000. | 24000. | 26000. | 28000. | 30000. |
| 47.50 1. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.51 2. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.52 3. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.53 4. | B O | . | . | . | . | . | . | . | . | . | . | . |
| 47.54 5. | B O. | . | . | . | . | . | . | . | . | . | . | . |
| 47.55 6. | B .O | . | . | . | . | . | . | . | . | . | . | . |
| 47.56 7. | B . O | . | . | . | . | . | . | . | . | . | . | . |
| 47.57 8. | B O | . | . | . | . | . | . | . | . | . | . | . |
| 47.58 9. | .B O | . | . | . | . | . | . | . | . | . | . | . |
| 47.59 10. |B.....O..... | | | | | | | | | | | |
| 47.60 11. | . | B O. | . | . | . | . | . | . | . | . | . | . |
| 47.61 12. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.62 13. | . | B . O | . | . | . | . | . | . | . | . | . | . |
| 47.63 14. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.64 15. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.65 16. | . | .B O | . | . | . | . | . | . | . | . | . | . |
| 47.66 17. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.67 18. | . | B O. | . | . | . | . | . | . | . | . | . | . |
| 47.68 19. | . | B .O | . | . | . | . | . | . | . | . | . | . |
| 47.69 20. |B.....O..... | | | | | | | | | | | |
| 47.70 21. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.71 22. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.72 23. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.73 24. | . | B O. | . | . | . | . | . | . | . | . | . | . |
| 47.74 25. | . | B | . | . | . | . | . | . | . | . | . | . |
| 47.75 26. | . | B | . | . | . | . | . | . | . | . | . | . |
| 47.76 27. | . | BO | . | . | . | . | . | . | . | . | . | . |
| 47.77 28. | . | BO | . | . | . | . | . | . | . | . | . | . |
| 47.78 29. | . | BO | . | . | . | . | . | . | . | . | . | . |
| 47.79 30. |BO..... | | | | | | | | | | | |
| 47.80 31. | . | BO | . | . | . | . | . | . | . | . | . | . |
| 47.81 32. | . | BO. | . | . | . | . | . | . | . | . | . | . |
| 47.82 33. | . | B .O | . | . | . | . | . | . | . | . | . | . |
| 47.83 34. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.84 35. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.85 36. | . | BO | . | . | . | . | . | . | . | . | . | . |
| 47.86 37. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.87 38. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.88 39. | . | B O. | . | . | . | . | . | . | . | . | . | . |
| 47.89 40. |B.O..... | | | | | | | | | | | |
| 47.90 41. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.91 42. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.92 43. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.93 44. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.94 45. | . | B O | . | . | . | . | . | . | . | . | . | . |
| 47.95 46. | . | BO | . | . | . | . | . | . | . | . | . | . |
| 47.96 47. | . | BO | . | . | . | . | . | . | . | . | . | . |
| 47.97 48. | . | BO | . | . | . | . | . | . | . | . | . | . |
| 47.98 49. | . | BO | . | . | . | . | . | . | . | . | . | . |
| 47.99 50. |BO..... | | | | | | | | | | | |
| 48.00 51. | . | B | . | . | . | . | . | . | . | . | . | . |

180VH*

DAM BREACH DATA

B
8/20

DAM BREACH DATA

| BRWID | Z | ELBM | TFAIL | WSEL | FAILEL |
|-------|------|--------|-------|--------|--------|
| 50. | 1.00 | 538.00 | 1.00 | 548.00 | 562.80 |

BEGIN DAM FAILURE AT 47.50 HOURS

PEAK OUTFLOW IS 26667. AT TIME 48.50 HOURS

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .021 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .250 HOURS.

THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

| TIME (HOURS) | TIME FROM BEGINNING OF BREACH (HOURS) | INTERPOLATED BREACH HYDROGRAPH (CFS) | COMPUTED BREACH HYDROGRAPH (CFS) | = ERROR (CFS) | ACCUMULATED ERROR (CFS) | ACCUMULATED ERROR (AC-FT) |
|-----------------|--|---|---|------------------|-------------------------------|---------------------------------|
| 47.500 | 0.000 | 8624. | 8624. | 0. | 0. | 0. |
| 47.521 | .021 | 8859. | 8800. | 60. | 60. | 0. |
| 47.542 | .042 | 9094. | 8948. | 146. | 205. | 0. |
| 47.563 | .063 | 9329. | 9122. | 207. | 413. | 1. |
| 47.583 | .083 | 9564. | 9317. | 247. | 660. | 1. |
| 47.604 | .104 | 9799. | 9531. | 268. | 928. | 2. |
| 47.625 | .125 | 10034. | 9763. | 272. | 1199. | 2. |
| 47.646 | .146 | 10269. | 10010. | 260. | 1459. | 3. |
| 47.667 | .167 | 10504. | 10271. | 233. | 1692. | 3. |
| 47.688 | .188 | 10739. | 10546. | 193. | 1885. | 3. |
| 47.708 | .208 | 10974. | 10834. | 140. | 2025. | 3. |
| 47.729 | .229 | 11209. | 11134. | 76. | 2100. | 4. |
| 47.750 | .250 | 11444. | 11444. | 0. | 2100. | 4. |
| 47.771 | .271 | 11817. | 11765. | 52. | 2152. | 4. |
| 47.792 | .292 | 12190. | 12095. | 95. | 2247. | 4. |
| 47.813 | .313 | 12563. | 12435. | 128. | 2375. | 4. |
| 47.833 | .333 | 12936. | 12782. | 154. | 2529. | 4. |
| 47.854 | .354 | 13309. | 13138. | 171. | 2700. | 5. |
| 47.875 | .375 | 13682. | 13500. | 181. | 2881. | 5. |
| 47.896 | .396 | 14055. | 13871. | 183. | 3064. | 5. |
| 47.917 | .417 | 14427. | 14268. | 160. | 3224. | 6. |
| 47.938 | .438 | 14800. | 14671. | 129. | 3354. | 6. |
| 47.958 | .458 | 15173. | 15081. | 92. | 3446. | 6. |
| 47.979 | .479 | 15546. | 15497. | 49. | 3494. | 6. |
| 48.000 | .500 | 15919. | 15919. | 0. | 3494. | 6. |
| 48.021 | .521 | 16372. | 16346. | 26. | 3520. | 6. |
| 48.042 | .542 | 16825. | 16787. | 38. | 3558. | 6. |
| 48.063 | .563 | 17278. | 17233. | 45. | 3603. | 6. |
| 48.083 | .583 | 17731. | 17682. | 49. | 3651. | 6. |
| 48.104 | .604 | 18184. | 18135. | 49. | 3700. | 6. |
| 48.125 | .625 | 18637. | 18591. | 46. | 3747. | 6. |
| 48.146 | .646 | 19090. | 19049. | 41. | 3788. | 7. |
| 48.167 | .667 | 19543. | 19509. | 35. | 3822. | 7. |
| 48.188 | .688 | 19996. | 19970. | 26. | 3849. | 7. |
| 48.208 | .708 | 20449. | 20431. | 18. | 3867. | 7. |
| 48.229 | .729 | 20902. | 20893. | 9. | 3875. | 7. |
| 48.250 | .750 | 21355. | 21355. | 0. | 3875. | 7. |
| 48.271 | .771 | 21798. | 21816. | -18. | 3857. | 7. |
| 48.292 | .792 | 22241. | 22275. | -35. | 3822. | 7. |
| 48.313 | .812 | 22683. | 22733. | -49. | 3773. | 6. |
| 48.333 | .833 | 23126. | 23187. | -62. | 3711. | 6. |
| 48.354 | .854 | 23569. | 23639. | -71. | 3641. | 6. |
| 48.375 | .875 | 24011. | 24087. | -76. | 3565. | 6. |

B
9/20

| TIME (HRS) | | (D) INTERPOLATED BREACH HYDROGRAPH (B) COMPUTED BREACH HYDROGRAPH | | | | | | | | | | | |
|---------------|-----|--|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|----|
| | | 8000. | 10000. | 12000. | 14000. | 16000. | 18000. | 20000. | 22000. | 24000. | 26000. | 28000. | 0. |
| 47.50 | 1. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.52 | 2. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.54 | 3. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.56 | 4. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.58 | 5. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.60 | 6. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.63 | 7. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.65 | 8. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.67 | 9. | .B O | . | . | . | . | . | . | . | . | . | . | . |
| 47.69 | 10. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.71 | 11. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.73 | 12. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.75 | 13. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.77 | 14. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.79 | 15. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.81 | 16. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.83 | 17. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.85 | 18. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.87 | 19. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.90 | 20. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.92 | 21. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.94 | 22. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.96 | 23. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.98 | 24. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 48.00 | 25. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.02 | 26. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.04 | 27. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.06 | 28. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.08 | 29. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 48.10 | 30. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.12 | 31. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.15 | 32. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.17 | 33. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.19 | 34. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.21 | 35. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.23 | 36. | BO | . | . | . | . | . | . | . | . | . | . | . |
| 48.25 | 37. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.27 | 38. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.29 | 39. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.31 | 40. | OB | . | . | . | . | . | . | . | . | . | . | . |
| 48.33 | 41. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.35 | 42. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.37 | 43. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.40 | 44. | OB | . | . | . | . | . | . | . | . | . | . | . |
| 48.42 | 45. | OB | . | . | . | . | . | . | . | . | . | . | . |
| 48.44 | 46. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.46 | 47. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.48 | 48. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.50 | 49. | B | . | . | . | . | . | . | . | . | . | . | . |

1:00VW*

DAM BREACH DATA

BRWD Z ELBM TFAIL WSEL FAILEL

DAM BREACH DATA

| BRWD | Z | ELBM | TFAIL | WSEL | FAILEL |
|------|------|--------|-------|--------|--------|
| 50. | 1.00 | 538.00 | 2.00 | 548.00 | 562.80 |

B
10/20

BEGIN DAM FAILURE AT 47.50 HOURS

PEAK OUTFLOW IS 26604. AT TIME 49.50 HOURS

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .042 HOURS DURING BREACH FORMATION.

DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .250 HOURS.

THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.

INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

| TIME (HOURS) | TIME FROM BEGINNING OF BREACH (HOURS) | INTERPOLATED BREACH HYDROGRAPH (CFS) | COMPUTED BREACH HYDROGRAPH (CFS) | = ERROR (CFS) | ACCUMULATED ERROR (CFS) | ACCUMULATED ERROR (AC-FT) |
|-----------------|--|---|---|------------------|-------------------------------|---------------------------------|
| 47.500 | 0.000 | 8624. | 8624. | 0. | 0. | 0. |
| 47.542 | .042 | 8820. | 8813. | 6. | 6. | 0. |
| 47.583 | .083 | 9015. | 8973. | 42. | 48. | 0. |
| 47.625 | .125 | 9210. | 9155. | 55. | 103. | 0. |
| 47.667 | .167 | 9406. | 9355. | 51. | 154. | 1. |
| 47.708 | .208 | 9601. | 9569. | 32. | 186. | 1. |
| 47.750 | .250 | 9797. | 9797. | 0. | 186. | 1. |
| 47.792 | .292 | 10054. | 10035. | 19. | 205. | 1. |
| 47.833 | .333 | 10311. | 10282. | 28. | 233. | 1. |
| 47.875 | .375 | 10568. | 10538. | 30. | 264. | 1. |
| 47.917 | .417 | 10825. | 10799. | 25. | 289. | 1. |
| 47.958 | .458 | 11082. | 11067. | 15. | 304. | 1. |
| 48.000 | .500 | 11339. | 11339. | 0. | 304. | 1. |
| 48.042 | .542 | 11632. | 11614. | 18. | 322. | 1. |
| 48.083 | .583 | 11926. | 11892. | 34. | 356. | 1. |
| 48.125 | .625 | 12220. | 12171. | 48. | 405. | 1. |
| 48.167 | .667 | 12514. | 12476. | 37. | 442. | 2. |
| 48.208 | .708 | 12807. | 12788. | 19. | 462. | 2. |
| 48.250 | .750 | 13101. | 13101. | 0. | 462. | 2. |
| 48.292 | .792 | 13423. | 13415. | 8. | 470. | 2. |
| 48.333 | .833 | 13745. | 13734. | 11. | 481. | 2. |
| 48.375 | .875 | 14067. | 14061. | 6. | 487. | 2. |
| 48.417 | .917 | 14389. | 14387. | 2. | 489. | 2. |
| 48.458 | .958 | 14711. | 14711. | 0. | 489. | 2. |
| 48.500 | 1.000 | 15033. | 15033. | 0. | 489. | 2. |
| 48.542 | 1.042 | 15340. | 15352. | -12. | 478. | 2. |
| 48.583 | 1.083 | 15647. | 15667. | -19. | 458. | 2. |
| 48.625 | 1.125 | 15955. | 15977. | -23. | 436. | 1. |
| 48.667 | 1.167 | 16262. | 16283. | -21. | 414. | 1. |
| 48.708 | 1.208 | 16569. | 16583. | -14. | 401. | 1. |
| 48.750 | 1.250 | 16877. | 16877. | -0. | 401. | 1. |
| 48.792 | 1.292 | 17142. | 17163. | -21. | 380. | 1. |
| 48.833 | 1.333 | 17407. | 17442. | -35. | 345. | 1. |
| 48.875 | 1.375 | 17673. | 17713. | -40. | 305. | 1. |
| 48.917 | 1.417 | 17938. | 17974. | -36. | 268. | 1. |
| 48.958 | 1.458 | 18204. | 18227. | -23. | 245. | 1. |
| 49.000 | 1.500 | 18469. | 18469. | 0. | 245. | 1. |
| 49.042 | 1.542 | 18673. | 18701. | -28. | 217. | 1. |
| 49.083 | 1.583 | 18877. | 18923. | -45. | 172. | 1. |
| 49.125 | 1.625 | 19082. | 19133. | -51. | 121. | 0. |
| 49.167 | 1.667 | 19286. | 19332. | -46. | 75. | 0. |
| 49.208 | 1.708 | 19490. | 19519. | -29. | 46. | 0. |
| 49.250 | 1.750 | 19695. | 19695. | 0. | 46. | 0. |

STATION 2

B

11/20

| TIME (HRS) | (A) INTERPOLATED BREACH HYDROGRAPH (B) COMPUTED BREACH HYDROGRAPH | | | | | | | | | | | |
|---------------|--|--------|--------|--------|--------|--------|--------|--------|----|----|----|----|
| | 8000. | 10000. | 12000. | 14000. | 16000. | 18000. | 20000. | 22000. | 0. | 0. | 0. | 0. |
| 47.50 1. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.54 2. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.58 3. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.63 4. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.67 5. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.71 6. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.75 7. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.79 8. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.83 9. | .BO | . | . | . | . | . | . | . | . | . | . | . |
| 47.88 10. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.92 11. | B | . | . | . | . | . | . | . | . | . | . | . |
| 47.96 12. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.00 13. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.04 14. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.08 15. | .BO | . | . | . | . | . | . | . | . | . | . | . |
| 48.13 16. | .B | . | . | . | . | . | . | . | . | . | . | . |
| 48.17 17. | .BO | . | . | . | . | . | . | . | . | . | . | . |
| 48.21 18. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.25 19. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.29 20. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.33 21. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.38 22. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.42 23. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.46 24. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.50 25. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.54 26. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.58 27. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.63 28. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.67 29. | .B | . | . | . | . | . | . | . | . | . | . | . |
| 48.71 30. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.75 31. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.79 32. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.83 33. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.88 34. | OB | . | . | . | . | . | . | . | . | . | . | . |
| 48.92 35. | B | . | . | . | . | . | . | . | . | . | . | . |
| 48.96 36. | .B | . | . | . | . | . | . | . | . | . | . | . |
| 49.00 37. | B | . | . | . | . | . | . | . | . | . | . | . |
| 49.04 38. | OB | . | . | . | . | . | . | . | . | . | . | . |
| 49.08 39. | OB | . | . | . | . | . | . | . | . | . | . | . |
| 49.13 40. | OB | . | . | . | . | . | . | . | . | . | . | . |
| 49.17 41. | OB | . | . | . | . | . | . | . | . | . | . | . |
| 49.21 42. | OB | . | . | . | . | . | . | . | . | . | . | . |
| 49.25 43. | B | . | . | . | . | . | . | . | . | . | . | . |
| 49.29 44. | B | . | . | . | . | . | . | . | . | . | . | . |
| 49.33 45. | B | . | . | . | . | . | . | . | . | . | . | . |
| 49.38 46. | .B | . | . | . | . | . | . | . | . | . | . | . |
| 49.42 47. | B | . | . | . | . | . | . | . | . | . | . | . |
| 49.46 48. | B | . | . | . | . | . | . | . | . | . | . | . |
| 49.50 49. | B | . | . | . | . | . | . | . | . | . | . | . |

140VNE

DAM BREACH DATA

DDUTH 7 ELEM TESTE UNCL EATIE

DAM BREACH DATA

B

12/20

| BRWID | Z | ELBM | TFAIL | WSEL | FAILEL |
|-------|------|--------|-------|--------|--------|
| 50. | 1.00 | 538.00 | 4.00 | 548.00 | 562.80 |

BEGIN DAM FAILURE AT 47.50 HOURS

PEAK OUTFLOW IS 13564. AT TIME 50.17 HOURS

1 THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .083 HOURS DURING BREACH FORMATION,
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .250 HOURS.

THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

| TIME (HOURS) | TIME FROM BEGINNING OF BREACH (HOURS) | INTERPOLATED BREACH HYDROGRAPH (CFS) | COMPUTED BREACH HYDROGRAPH (CFS) | = ERROR (CFS) | ACCUMULATED ERROR (CFS) | ACCUMULATED ERROR (AC-FT) |
|-----------------|--|---|---|------------------|-------------------------------|---------------------------------|
| 47.500 | 0.000 | 8624. | 8624. | 0. | 0. | 0. |
| 47.583 | .083 | 8819. | 8840. | -20. | -20. | -0. |
| 47.667 | .167 | 9015. | 9018. | -3. | -23. | -0. |
| 47.750 | .250 | 9210. | 9210. | 0. | -23. | -0. |
| 47.833 | .333 | 9414. | 9411. | 4. | -20. | -0. |
| 47.917 | .417 | 9618. | 9616. | 3. | -17. | -0. |
| 48.000 | .500 | 9823. | 9823. | 0. | -17. | -0. |
| 48.083 | .583 | 10026. | 10029. | -3. | -20. | -0. |
| 48.167 | .667 | 10230. | 10233. | -3. | -23. | -0. |
| 48.250 | .750 | 10434. | 10434. | 0. | -23. | -0. |
| 48.333 | .833 | 10625. | 10629. | -4. | -27. | -0. |
| 48.417 | .917 | 10817. | 10817. | -1. | -27. | -0. |
| 48.500 | 1.000 | 11008. | 11008. | 0. | -27. | -0. |
| 48.583 | 1.083 | 11216. | 11223. | -7. | -34. | -0. |
| 48.667 | 1.167 | 11425. | 11431. | -7. | -41. | -0. |
| 48.750 | 1.250 | 11633. | 11633. | 0. | -41. | -0. |
| 48.833 | 1.333 | 11834. | 11843. | -9. | -50. | -0. |
| 48.917 | 1.417 | 12035. | 12044. | -9. | -59. | -0. |
| 49.000 | 1.500 | 12236. | 12236. | 0. | -59. | -0. |
| 49.083 | 1.583 | 12406. | 12418. | -12. | -71. | -0. |
| 49.167 | 1.667 | 12576. | 12588. | -12. | -82. | -1. |
| 49.250 | 1.750 | 12746. | 12746. | 0. | -82. | -1. |
| 49.333 | 1.833 | 12878. | 12891. | -13. | -96. | -1. |
| 49.417 | 1.917 | 13010. | 13024. | -13. | -109. | -1. |
| 49.500 | 2.000 | 13143. | 13143. | 0. | -109. | -1. |
| 49.583 | 2.083 | 13233. | 13247. | -15. | -124. | -1. |
| 49.667 | 2.167 | 13323. | 13337. | -15. | -139. | -1. |
| 49.750 | 2.250 | 13413. | 13413. | 0. | -139. | -1. |
| 49.833 | 2.333 | 13458. | 13473. | -15. | -153. | -1. |
| 49.917 | 2.417 | 13503. | 13518. | -15. | -168. | -1. |
| 50.000 | 2.500 | 13548. | 13548. | 0. | -168. | -1. |
| 50.083 | 2.583 | 13548. | 13563. | -15. | -183. | -1. |
| 50.167 | 2.667 | 13548. | 13564. | -15. | -199. | -1. |
| 50.250 | 2.750 | 13549. | 13549. | 0. | -199. | -1. |
| 50.333 | 2.833 | 13528. | 13518. | 10. | -189. | -1. |
| 50.417 | 2.917 | 13507. | 13502. | 5. | -184. | -1. |
| 50.500 | 3.000 | 13486. | 13486. | 0. | -184. | -1. |
| 50.583 | 3.083 | 13435. | 13453. | -18. | -202. | -1. |
| 50.667 | 3.167 | 13384. | 13402. | -18. | -220. | -2. |
| 50.750 | 3.250 | 13333. | 13333. | 0. | -220. | -2. |
| 50.833 | 3.333 | 13229. | 13246. | -17. | -237. | -2. |
| 50.917 | 3.417 | 13125. | 13143. | -17. | -254. | -2. |
| 51.000 | 3.500 | 13022. | 13022. | 0. | -254. | -2. |

TIME
(HRS)

(O) INTERPOLATED BREACH HYDROGRAPH

(B) COMPUTED BREACH HYDROGRAPH

| | 8500. | 9000. | 9500. | 10000. | 10500. | 11000. | 11500. | 12000. | 12500. | 13000. | 13500. | 14000. |
|-----------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 47.50 1. | B | | | | | | | | | | | |
| 47.58 2. | OB | | | | | | | | | | | |
| 47.67 3. | | B | | | | | | | | | | |
| 47.75 4. | | | B | | | | | | | | | |
| 47.83 5. | | | | B | | | | | | | | |
| 47.92 6. | | | | | B | | | | | | | |
| 48.00 7. | | | | | | B | | | | | | |
| 48.08 8. | | | | | | | B | | | | | |
| 48.17 9. | | | | | | | | B | | | | |
| 48.25 10. | | | | | | | | | B | | | |
| 48.33 11. | | | | | | | B | | | | | |
| 48.42 12. | | | | | | | | B | | | | |
| 48.50 13. | | | | | | | | | B | | | |
| 48.58 14. | | | | | | | | | | B | | |
| 48.67 15. | | | | | | | | OB | | | | |
| 48.75 16. | | | | | | | | | B | | | |
| 48.83 17. | | | | | | | | | | B | | |
| 48.92 18. | | | | | | | | | | | B | |
| 49.00 19. | | | | | | | | | | | | B |
| 49.08 20. | | | | | | | | | | | | |
| 49.17 21. | | | | | | | | | | | | |
| 49.25 22. | | | | | | | | | | | | |
| 49.33 23. | | | | | | | | | | | | |
| 49.42 24. | | | | | | | | | | | | |
| 49.50 25. | | | | | | | | | | | | |
| 49.58 26. | | | | | | | | | | | | |
| 49.67 27. | | | | | | | | | | | | |
| 49.75 28. | | | | | | | | | | | | |
| 49.83 29. | | | | | | | | | | | | |
| 49.92 30. | | | | | | | | | | | | |
| 50.00 31. | | | | | | | | | | | | |
| 50.08 32. | | | | | | | | | | | | |
| 50.17 33. | | | | | | | | | | | | |
| 50.25 34. | | | | | | | | | | | | |
| 50.33 35. | | | | | | | | | | | | |
| 50.42 36. | | | | | | | | | | | | |
| 50.50 37. | | | | | | | | | | | | |
| 50.58 38. | | | | | | | | | | | | |
| 50.67 39. | | | | | | | | | | | | |
| 50.75 40. | | | | | | | | | | | | |
| 50.83 41. | | | | | | | | | | | | |
| 50.92 42. | | | | | | | | | | | | |
| 51.00 43. | | | | | | | | | | | | |
| 51.08 44. | | | | | | | | | | | | |
| 51.17 45. | | | | | | | | | | | | |
| 51.25 46. | | | | | | | | | | | | |
| 51.33 47. | | | | | | | | | | | | |
| 51.42 48. | | | | | | | | | | | | |
| 51.50 49. | | | | | | | | | | | | |

1#OVN#

HYDROGRAPH ROUTING

B
14/20

REACH 2-3

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUTO
3 1 0 0 0 0 1 0 0

ALL PLANS HAVE SAME

ROUTING DATA

CLOSS CLOSS AVG IRES ISAME IOPT IPMP LSTR
0.0 0.000 0.00 1 1 0 0 0

NSTPS NSTDL LAG AMSKK X TSK STORA ISPRAT
1 0 0 0.000 0.000 0.000 0. 0

NORMAL DEPTH CHANNEL ROUTING

QN(1) QN(2) QN(3) ELNVT ELMAX RLNTH SEL
.1000 .0400 .1000 525.0 560.0 200. .01000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 560.00 90.00 540.00 200.00 530.00 205.00 525.00 220.00 525.00
225.00 530.00 250.00 540.00 1100.00 560.00

STORAGE 0. 0. 0. 1. 1. 1. 2. 3. 5. 6.
8. 12. 15. 20. 25. 31. 38. 45. 54. 63.

OUTFLOW 0. 154. 498. 1042. 1902. 3099. 4699. 6759. 9333. 12402.
16620. 22061. 28926. 37413. 47708. 59985. 74411. 91147. 110348. 132163.

STAGE 525.0 526.8 528.7 530.5 532.4 534.2 536.1 537.9 539.7 541.6
543.4 545.3 547.1 548.9 550.8 552.6 554.5 556.3 558.2 560.0

FLOW 0. 154. 498. 1042. 1902. 3099. 4699. 6759. 9333. 12402.
16620. 22061. 28926. 37413. 47708. 59985. 74411. 91147. 110348. 132163.

MAXIMUM STAGE IS 547.6

MAXIMUM STAGE IS 547.4

MAXIMUM STAGE IS 546.5

MAXIMUM STAGE IS 544.8

MAXIMUM STAGE IS 542.1

HYDROGRAPH ROUTING

REACH 3-4

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUTO
4 1 0 0 0 0 1 0 0

B
15/20

HYDROGRAPH ROUTING

REACH 3-4

| ISTAD | ICOMP | IECON | ITAPE | JPLT | JFRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 4 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ALL PLANS HAVE SAME
ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|-------|-------|------|------|-------|------|------|------|
| 0.0 | 0.000 | 0.00 | 1 | 1 | 0 | 0 | 0 |

| NSTPS | NSTD | LAG | AMSK | X | TSK | STOR | ISPRAT |
|-------|------|-----|-------|-------|-------|------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 0. | 0 |

NORMAL DEPTH CHANNEL ROUTING

| QN(1) | QN(2) | QN(3) | ELNVT | ELMAX | RLNTH | SEL |
|-------|-------|-------|-------|-------|-------|--------|
| .1000 | .0400 | .1000 | 523.0 | 560.0 | 1200. | .00170 |

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

| | | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0.00 | 560.00 | 50.00 | 540.00 | 100.00 | 528.00 | 110.00 | 523.00 | 120.00 | 523.00 |
| 130.00 | 528.00 | 470.00 | 540.00 | 630.00 | 560.00 | | | | |

| | 0. | 1. | 2. | 4. | 9. | 17. | 28. | 43. | 62. | 83. |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| STORAGE | 107. | 131. | 157. | 183. | 211. | 240. | 270. | 301. | 333. | 366. |
| OUTFLOW | 13508. | 17806. | 22669. | 28093. | 34079. | 40629. | 47744. | 55432. | 63697. | 72545. |
| STAGE | 523.0 | 524.9 | 526.9 | 528.8 | 530.8 | 532.7 | 534.7 | 536.6 | 538.6 | 540.5 |
| | 542.5 | 544.4 | 546.4 | 548.3 | 550.3 | 552.2 | 554.2 | 556.1 | 558.1 | 560.0 |
| FLOW | 13508. | 17806. | 22669. | 28093. | 34079. | 40629. | 47744. | 55432. | 63697. | 72545. |

MAXIMUM STAGE IS 549.7

MAXIMUM STAGE IS 548.4

MAXIMUM STAGE IS 547.3

MAXIMUM STAGE IS 545.4

MAXIMUM STAGE IS 542.5

HYDROGRAPH ROUTING

REACH 4-5

| ISTAD | ICOMP | IECON | ITAPE | JPLT | JFRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
|-------|-------|-------|-------|------|------|-------|--------|-------|

B

16/20

HYDROGRAPH ROUTING

REACH 4-5

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ALL PLANS HAVE SAME
ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|-------|-------|------|------|-------|------|------|------|
| 0.0 | 0.000 | 0.00 | 1 | 1 | 0 | 0 | 0 |

| NSTPS | NSTDL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|-------|-------|-----|-------|-------|-------|-------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 0. | 0 |

NORMAL DEPTH CHANNEL ROUTING

| QN(1) | QN(2) | QN(3) | ELNVT | ELMAX | RLNTH | SEL |
|-------|-------|-------|-------|-------|-------|--------|
| .1000 | .0400 | .1000 | 521.0 | 560.0 | 1000. | .00200 |

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

| | | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0.00 | 560.00 | 200.00 | 540.00 | 450.00 | 525.00 | 520.00 | 521.00 | 528.00 | 521.00 |
| 530.00 | 525.00 | 700.00 | 540.00 | 830.00 | 560.00 | | | | |

| STORAGE | 0. | 1. | 4. | 10. | 17. | 28. | 42. | 58. | 76. | 98. |
|---------|------|------|------|------|------|------|------|------|------|------|
| | 122. | 147. | 175. | 203. | 234. | 266. | 299. | 334. | 371. | 409. |

| OUTFLOW | 0. | 101. | 525. | 1563. | 3157. | 5368. | 8251. | 11863. | 16261. | 21497. |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|
| | 27832. | 35113. | 43270. | 52319. | 62274. | 73152. | 84972. | 97754. | 111515. | 126276. |

| STAGE | 521.0 | 523.1 | 525.1 | 527.2 | 529.2 | 531.3 | 533.3 | 535.4 | 537.4 | 539.5 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 541.5 | 543.6 | 545.6 | 547.7 | 549.7 | 551.8 | 553.8 | 555.9 | 557.9 | 560.0 |

| FLOW | 0. | 101. | 525. | 1563. | 3157. | 5368. | 8251. | 11863. | 16261. | 21497. |
|------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|
| | 27832. | 35113. | 43270. | 52319. | 62274. | 73152. | 84972. | 97754. | 111515. | 126276. |

MAXIMUM STAGE IS 542.6

MAXIMUM STAGE IS 542.0

MAXIMUM STAGE IS 540.6

MAXIMUM STAGE IS 539.0

MAXIMUM STAGE IS 536.2

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

B
 17/20

OPERATION STATION AREA PLAN RATIO 1
 .34

RATIOS APPLIED TO FLOWS

HYDROGRAPH AT 1 20.50 1 10138.
 (53.09) (287.07)(
 2 10138.
 (287.07)(
 3 10138.
 (287.07)(
 4 10138.
 (287.07)(
 5 10138.
 (287.07)(

ROUTED TO 2 20.50 1 32629.
 (53.09) (923.95)(
 2 30491.
 (863.41)(
 3 26667.
 (755.14)(
 4 20604.
 (583.43)(
 5 13549.
 (383.65)(

ROUTED TO 3 20.50 1 31420.
 (53.09) (889.72)(
 2 30109.
 (852.59)(
 3 26561.
 (752.11)(
 4 20586.
 (582.93)(
 5 13550.
 (383.69)(

ROUTED TO 4 20.50 1 32217.
 (53.09) (912.28)(
 2 28500.
 (807.02)(
 3 25271.
 (715.60)(
 4 20364.
 (576.63)(
 5 13559.
 (383.95)(

ROUTED TO 5 20.50 1 31816.
 (53.09) (900.94)(
 2 29382.
 (832.02)(
 3 24943.
 (706.31)(
 4 20197.
 (571.92)(

SUMMARY OF DAM SAFETY ANALYSIS

| PLAN 1 | | | | | | | |
|--------------|----------------------------|------------------------|-----------------------|---------------------|-------------------------|---------------------------|-----------------------|
| | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM | | | |
| ELEVATION | | 548.00 | 548.00 | 562.30 | | | |
| STORAGE | | 1104. | 1104. | 3107. | | | |
| OUTFLOW | | 0. | 0. | 8030. | | | |
| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
| .34 | 562.82 | .52 | 3210. | 32629. | 1.21 | 47.75 | 47.50 |
| PLAN 2 | | | | | | | |
| | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM | | | |
| ELEVATION | | 548.00 | 548.00 | 562.30 | | | |
| STORAGE | | 1104. | 1104. | 3107. | | | |
| OUTFLOW | | 0. | 0. | 8030. | | | |
| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
| .34 | 562.83 | .53 | 3212. | 30491. | 1.32 | 48.00 | 47.50 |
| PLAN 3 | | | | | | | |
| | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM | | | |
| ELEVATION | | 548.00 | 548.00 | 562.30 | | | |
| STORAGE | | 1104. | 1104. | 3107. | | | |
| OUTFLOW | | 0. | 0. | 8030. | | | |
| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
| .34 | 562.84 | .54 | 3214. | 26667. | 1.50 | 48.50 | 47.50 |
| PLAN 4 | | | | | | | |
| | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM | | | |
| ELEVATION | | 548.00 | 548.00 | 562.30 | | | |
| STORAGE | | 1104. | 1104. | 3107. | | | |
| OUTFLOW | | 0. | 0. | 8030. | | | |
| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
| .34 | 562.86 | .56 | 3218. | 20604. | 1.79 | 49.50 | 47.50 |
| PLAN 5 | | | | | | | |
| | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM | | | |
| ELEVATION | | 548.00 | 548.00 | 562.30 | | | |
| STORAGE | | 1104. | 1104. | 3107. | | | |
| OUTFLOW | | 0. | 0. | 8030. | | | |

B
19/20

| RATIO OF PMF | MAXIMUM RESERVOIR W.S. ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|--------------------|-----------------------------------|------------------------------|-----------------------------|---------------------------|-------------------------------|---------------------------------|-----------------------------|
| .34 | 562.89 | .59 | 3224. | 13564. | 2.17 | 50.17 | 47.50 |

PLAN 1 STATION 3

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------|----------------------|----------------------|---------------|
| .34 | 31420. | 547.6 | 47.75 |

PLAN 2 STATION 3

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------|----------------------|----------------------|---------------|
| .34 | 30109. | 547.4 | 48.00 |

PLAN 3 STATION 3

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------|----------------------|----------------------|---------------|
| .34 | 26561. | 546.5 | 48.50 |

PLAN 4 STATION 3

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------|----------------------|----------------------|---------------|
| .34 | 20586. | 544.8 | 49.50 |

PLAN 5 STATION 3

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------|----------------------|----------------------|---------------|
| .34 | 13550. | 542.1 | 50.00 |

PLAN 1 STATION 4

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------|----------------------|----------------------|---------------|
| .34 | 32217. | 549.7 | 48.00 |

PLAN 2 STATION 4

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|-------|----------------------|----------------------|---------------|
| .34 | 28500. | 548.4 | 48.25 |

PLAN 3 STATION 4

B
20/20

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|-------|---------------------|---------------------|---------------|
| .34 | 25271. | 547.3 | 48.50 |

PLAN 4 STATION 4

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|-------|---------------------|---------------------|---------------|
| .34 | 20364. | 545.4 | 49.50 |

PLAN 5 STATION 4

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|-------|---------------------|---------------------|---------------|
| .34 | 13559. | 542.5 | 50.25 |

PLAN 1 STATION 5

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|-------|---------------------|---------------------|---------------|
| .34 | 31816. | 542.6 | 48.00 |

PLAN 2 STATION 5

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|-------|---------------------|---------------------|---------------|
| .34 | 29382. | 542.0 | 48.25 |

PLAN 3 STATION 5

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|-------|---------------------|---------------------|---------------|
| .34 | 24943. | 540.6 | 48.75 |

PLAN 4 STATION 5

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|-------|---------------------|---------------------|---------------|
| .34 | 20197. | 539.0 | 49.50 |

PLAN 5 STATION 5

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|-------|---------------------|---------------------|---------------|
| .34 | 13557. | 536.2 | 50.25 |

1*****

FLOOD HYDROGRAPH PACKAGE (HEC-1)

DAM SAFETY VERSION JULY 1978

LAST MODIFICATION 21 AUG 78

OVERTOPPING ANALYSIS

IMPROVED EMBANKMENT

114

| | | | | | | | | | | | |
|----|----|--|------|------|------|------|-------|------|-----|----|----|
| 1 | A1 | SWEET ARROW LAKE DAM **** UPPER LITTLE SWATARA CREEK | | | | | | | | | |
| 2 | A2 | PINE GROVE TWP., SCHUYLKILL COUNTY | | | | | | | | | |
| 3 | A3 | NDI # PA-00680 PA DER # 54-102 | | | | | | | | | |
| 4 | B | 300 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | -4 |
| 5 | B1 | 5 | | | | | | | | | 0 |
| 6 | J | 1 | 9 | 1 | | | | | | | |
| 7 | J1 | 1 | .85 | .7 | .6 | .5 | .4 | .3 | .2 | .1 | |
| 8 | K | | 1 | | | | | 1 | | | |
| 9 | K1 | INFLOW HYDROGRAPH | | | | | | | | | |
| 10 | H | 1 | 1 | 20.5 | | | | | | | |
| 11 | P | | 23.2 | 106 | 116 | 125 | 136.5 | | | | |
| 12 | T | | | | | | | 1 | .05 | | |
| 13 | W | 7.3 | .85 | | | | | | | | |
| 14 | X | -1.5 | -.05 | 2 | | | | | | | |
| 15 | K | 1 | 2 | | | | | 1 | | | |
| 16 | K1 | RESERVOIR ROUTING | | | | | | | | | |
| 17 | Y | | | 1 | 0 | | | | | | |
| 18 | Y1 | 1 | | | | | | 1105 | -1 | | |
| 19 | Y4 | 548 | 549 | 551 | 554 | 558 | 562.5 | | | | |
| 20 | Y5 | 0 | 149 | 772 | 2182 | 4696 | 8200 | | | | |
| 21 | YA | 0 | 92 | 175 | 404 | | | | | | |
| 22 | YE | 512 | 548 | 560 | 580 | | | | | | |
| 23 | YH | 548 | | | | | | | | | |
| 24 | YD | 562.5 | 2.7 | 1.5 | 450 | | | | | | |
| 25 | K | 99 | | | | | | | | | |

1 PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 1
ROUTE HYDROGRAPH TO 2
END OF NETWORK

1*****

FLOOD HYDROGRAPH PACKAGE (HEC-1)

DAM SAFETY VERSION JULY 1978

LAST MODIFICATION 21 AUG 78

RUN DATE* 79/02/23.

TIME* 07.44.59.

SWEET ARROW LAKE DAM **** UPPER LITTLE SWATARA CREEK
PINE GROVE TWP., SCHUYLKILL COUNTY
NDI # PA-00680 PA DER # 54-102

JOB SPECIFICATION

| NO | NHR | NHIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|-----|-----|------|-------|-----|-------|-------|------|------|-------|
| 300 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | -4 | 0 |
| | | | JOPER | NWT | LROPT | TRACE | | | |
| | | | 5 | 0 | 0 | 0 | | | |

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS= 1.00 .85 .70 .60 .50 .40 .30 .20 .10

SWEET ARROW LAKE DAM *** UPPER LITTLE SWATARA CREEK
 PINE GROVE TWP., SCHUYLKILL COUNTY
 NDI # PA-00680 PA DER # 54-102

2/4

JOB SPECIFICATION

| NQ | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|-----|-----|------|-------|-----|-------|-------|------|------|-------|
| 300 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | -4 | 0 |
| | | | JOPER | NWT | LROPT | TRACE | | | |
| | | | 5 | 0 | 0 | 0 | | | |

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS= 1.00 .85 .70 .60 .50 .40 .30 .20 .10

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUNG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|-------|------|-------|------|-------|-------|-------|-------|-------|-------|
| 1 | 1 | 20.50 | 0.00 | 20.50 | 0.00 | 0.000 | 0 | 0 | 0 |

PRECIP DATA

| SPFE | PMS | R6 | R12 | R24 | R48 | R72 | R96 |
|------|-------|--------|--------|--------|--------|------|------|
| 0.00 | 23.20 | 106.00 | 116.00 | 125.00 | 136.50 | 0.00 | 0.00 |

TRSPC COMPUTED BY THE PROGRAM IS .824

LOSS DATA

| LROPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 1.00 | .05 | 0.00 | 0.00 |

UNIT HYDROGRAPH DATA

TP= 7.30 CP= .85 NTA= 0

RECESSION DATA

STRTO= -1.50 ORCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 67 END-OF-PERIOD ORDINATES, LAG= 7.22 HOURS, CP= .81 VOL= 1.00

| | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 17. | 62. | 124. | 194. | 269. | 345. | 422. | 498. | 574. | 648. |
| 720. | 791. | 859. | 925. | 990. | 1052. | 1112. | 1171. | 1227. | 1282. |
| 1336. | 1387. | 1436. | 1478. | 1509. | 1530. | 1542. | 1547. | 1546. | 1538. |
| 1525. | 1506. | 1484. | 1457. | 1426. | 1392. | 1353. | 1311. | 1266. | 1216. |
| 1162. | 1102. | 1036. | 962. | 869. | 762. | 660. | 572. | 495. | 429. |
| 371. | 322. | 279. | 241. | 209. | 181. | 157. | 136. | 118. | 102. |
| 88. | 76. | 66. | 57. | 50. | 43. | 37. | | | |

END-OF-PERIOD FLOW

| NO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | NO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|-------|-------|--------|------|------|------|--------|-------|-------|--------|------|------|------|--------|
|-------|-------|--------|------|------|------|--------|-------|-------|--------|------|------|------|--------|

SUM 26.09 23.66 2.43 1258242.
 (663.)(601.)(62.)(35629.45)

HYDROGRAPH ROUTING

RESERVOIR ROUTING

| | | | | | | | | |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
| 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| | | | | | | | |
|-------|-------|------|------|-------|------|------|------|
| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | 0 |

| | | | | | | | |
|-------|--------|-----|-------|-------|-------|-------|--------|
| NSTPS | NSTD L | LAG | AMSKK | X | TSK | STORA | ISPRAT |
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 1105. | -1 |

| | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|
| STAGE | 548.0 | 549.0 | 551.0 | 554.0 | 558.0 | 562.5 |
|-------|-------|-------|-------|-------|-------|-------|

| | | | | | | |
|------|----|------|------|-------|-------|-------|
| FLOW | 0. | 149. | 772. | 2182. | 4696. | 8200. |
|------|----|------|------|-------|-------|-------|

| | | | | |
|---------------|----|-----|------|------|
| SURFACE AREA= | 0. | 92. | 175. | 404. |
|---------------|----|-----|------|------|

| | | | | |
|-----------|----|-------|-------|-------|
| CAPACITY= | 0. | 1104. | 2680. | 8312. |
|-----------|----|-------|-------|-------|

| | | | | |
|------------|------|------|------|------|
| ELEVATION= | 512. | 548. | 560. | 580. |
|------------|------|------|------|------|

| | | | | | | | |
|-------|-------|------|------|------|------|-------|------|
| CREL | SPWID | COOW | EXPW | ELEV | COOL | CAREA | EXPL |
| 548.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| | | | |
|-------|------|------|--------|
| TOPEL | COOD | EXPD | DAMWID |
| 562.5 | 2.7 | 1.5 | 450. |

PEAK OUTFLOW IS 29477. AT TIME 47.00 HOURS

PEAK OUTFLOW IS 25032. AT TIME 47.00 HOURS

PEAK OUTFLOW IS 20568. AT TIME 47.00 HOURS

PEAK OUTFLOW IS 17558. AT TIME 47.00 HOURS

PEAK OUTFLOW IS 14483. AT TIME 47.25 HOURS

PEAK OUTFLOW IS 11177. AT TIME 47.75 HOURS

PEAK OUTFLOW IS 7659. AT TIME 48.50 HOURS

PEAK OUTFLOW IS 5286. AT TIME 48.25 HOURS

PEAK OUTFLOW IS 2522. AT TIME 48.75 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

| OPERATION | STATION | AREA | PLAN | RATIOS APPLIED TO FLOWS | | | | | | | | |
|---------------|---------|----------|------|-------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|
| | | | | RATIO 1 | RATIO 2 | RATIO 3 | RATIO 4 | RATIO 5 | RATIO 6 | RATIO 7 | RATIO 8 | RATIO 9 |
| | | | | 1.00 | .85 | .70 | .60 | .50 | .40 | .30 | .20 | .10 |
| HYDROGRAPH AT | 1 | 20.50 | 1 | 29817. | 25345. | 20872. | 17890. | 14909. | 11927. | 8945. | 5963. | 2982. |
| | | (53.09) | | (844.33) | (717.68) | (591.03) | (506.60) | (422.17) | (337.73) | (253.30) | (168.87) | (84.43) |
| ROUTED TO | 2 | 20.50 | 1 | 29477. | 25032. | 20568. | 17558. | 14483. | 11177. | 7659. | 5286. | 2522. |
| | | (53.09) | | (834.69) | (708.81) | (582.42) | (497.18) | (410.11) | (316.50) | (216.89) | (149.68) | (71.40) |

SUMMARY OF DAM SAFETY ANALYSIS

| PLAN 1 | | INITIAL VALUE | | SPILLWAY CREST | | TOP OF DAM | |
|--------------|--|---------------|--|----------------|--|------------|--|
| ELEVATION | | 548.01 | | 548.00 | | 562.50 | |
| STORAGE | | 1105. | | 1104. | | 3146. | |
| OUTFLOW | | 1. | | 0. | | 8200. | |

| RATIO | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | DURATION | TIME OF | TIME OF |
|-------|-----------|----------|---------|---------|----------|-------------|---------|
| OF | RESERVOIR | DEPTH | STORAGE | OUTFLOW | OVER TOP | MAX OUTFLOW | FAILURE |
| PMF | W.S.ELEV | OVER DAM | AC-FT | CFS | HOURS | HOURS | HOURS |
| 1.00 | 568.34 | 5.84 | 4478. | 29477. | 11.50 | 47.00 | 0.00 |
| .85 | 567.44 | 4.94 | 4249. | 25032. | 10.75 | 47.00 | 0.00 |
| .70 | 566.46 | 3.96 | 4010. | 20568. | 9.50 | 47.00 | 0.00 |
| .60 | 565.73 | 3.23 | 3840. | 17558. | 8.50 | 47.00 | 0.00 |
| .50 | 564.92 | 2.42 | 3655. | 14483. | 7.25 | 47.25 | 0.00 |
| .40 | 563.89 | 1.39 | 3432. | 11177. | 5.25 | 47.75 | 0.00 |
| .30 | 561.74 | 0.00 | 2997. | 7659. | 0.00 | 48.50 | 0.00 |
| .20 | 558.38 | 0.00 | 2407. | 5286. | 0.00 | 48.25 | 0.00 |
| .10 | 554.54 | 0.00 | 1839. | 2522. | 0.00 | 48.75 | 0.00 |

 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 21 AUG 78

 EOI ENCOUNTERED.

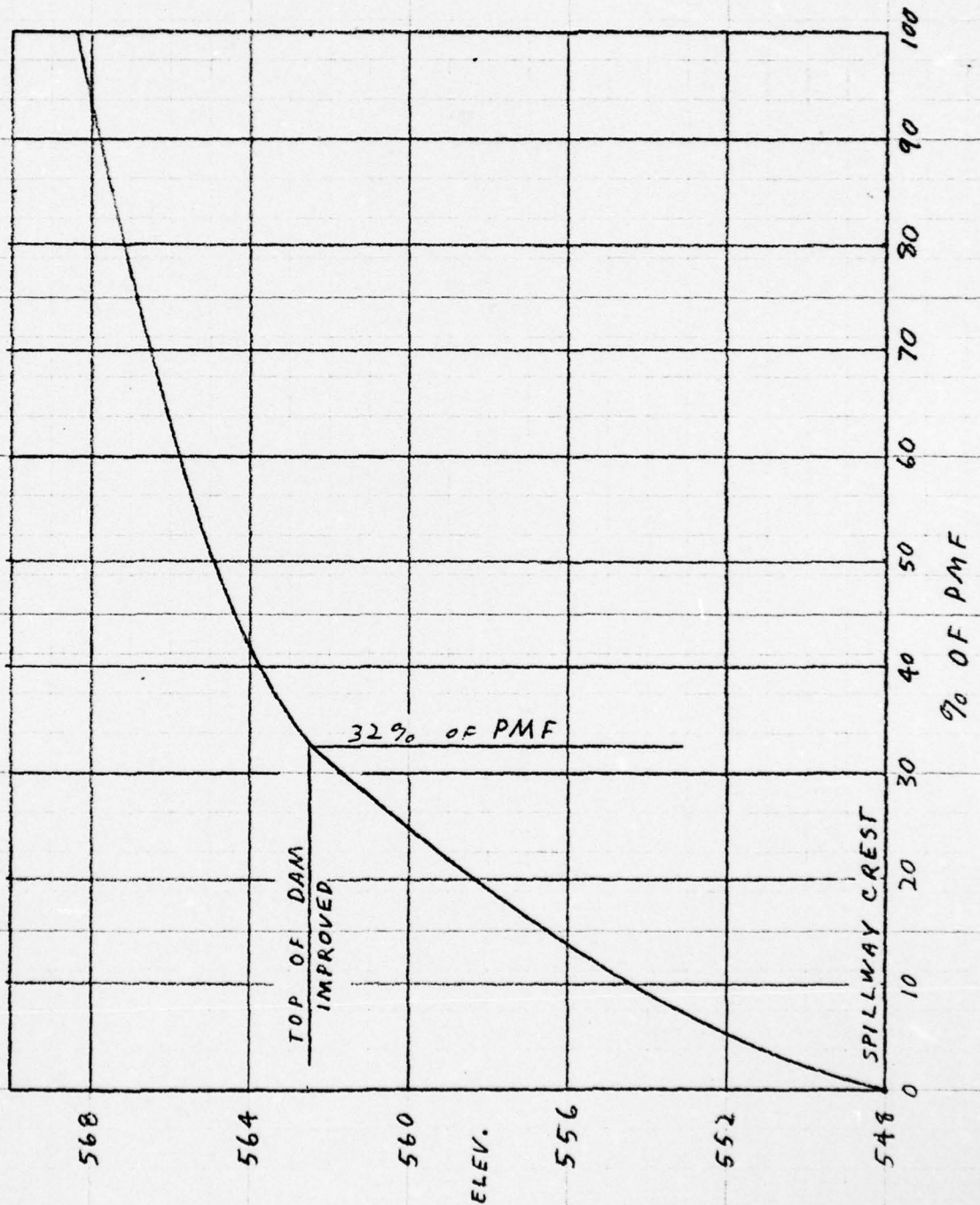
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BY RLS DATE 2/23/79
CHKD. BY _____ DATE _____
SUBJECT _____

BERGER ASSOCIATES

SHEET NO. _____ OF _____
PROJECT D8490

SPILLWAY RATING CURVE
IMPROVED EMBANKMENT



APPENDIX D
GEOLOGIC REPORT

APPENDIX D

GEOLOGIC REPORT

Bedrock - Dam

Formation Name: Mahantango Formation, Montebello Sandstone Member.

Lithology: The Montebello Sandstone consists of gray, olive gray, yellowish brown and olive brown sandstone, with some conglomerate, conglomeratic sandstone siltstone or shale interbeds.

Bedrock - Reservoir

Formation Names: Bloomsburg Red Beds; Ridgeley Sandstone; Selinsgrove Limestone; Marcellus Formation and Mahantango Formation, including the lower shale and sandstone member, Montebello Sandstone Member, and upper shale member.

Lithologies: Bloomsburg Red beds, red shales and siltstones, locally calcareous; Ridgeley Sandstone, coarse to medium sandstone, with calcite cement; Selinsgrove limestone, gray, shaly, cherty limestone; Marcellus shale, black fissile shale, Mahantango Formation, dark gray silty shales, siltstones with interbedded sandstones, includes the Montebello Sandstone described above.

Structure

The Sweet Arrow Dam is located on the north flank of the Roedersville Anticline, an overturned, faulted anticline whose axis trends N70°E. Bedding in the Montebello Sandstone near the west end of the dam strikes N50°E and dips 50°SE, and is overturned. Fracture traces trend N25°E, N5°E, N40°W, N20°W and N70°W.

The area is one of tight folds and considerable faulting. Fracture cleavage is generally present in the silty and shaly rocks. Two branches of the Sweet Arrow Fault, a major thrust fault, pass through the reservoir. The strike of these faults is about N65°E and then dips steeply south. These faults formed at the times of folding, about 270 to 300 million years ago. There has been no known subsequent activity of these faults.

AD-A070 613

BERGER ASSOCIATES INC HARRISBURG PA

F/G 13/2

NATIONAL DAM INSPECTION PROGRAM. SWEET ARROW LAKE DAM (NDI-PA-0--ETC(U)

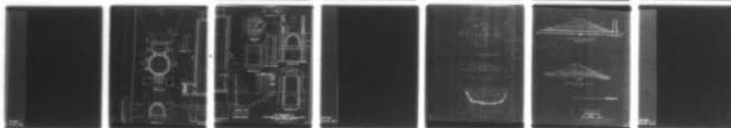
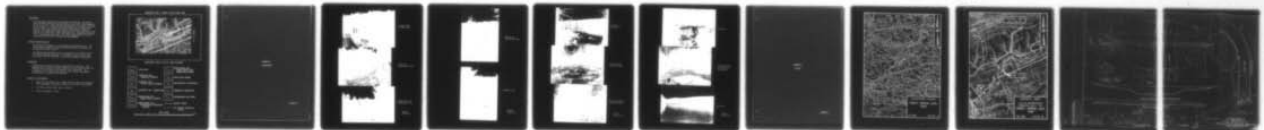
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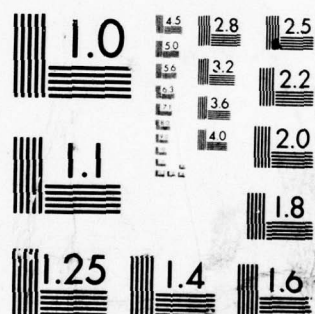
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Overburden

No drill hole information is available for this dam. The Montebello Sandstone does not weather deeply, fresh rock can be expected at 10 to 15 feet. Some alluvium was present in the valley of Little Swatara Creek. The plans for the dam called for a cutoff trench dug "to sound rock" and for grouting as indicated by pressure testing. An inspection report, dated July 21, 1923, states that the rock in the trench was "a hard fine grain (sic) sandstone which dips 70° in a downstream direction, the strike being about 15° to the centerline" of the dam. Grouting was recommended.

Aquifer Characteristics

The Montebello Sandstone is an essentially impermeable rock. All ground water movement is along bedding planes and fractures; and is generally rather limited.

The Selinsgrove limestone, which is exposed in the reservoir area is locally somewhat cavernous. Its outcrop is not close to the dam itself, and its structure is such that leakage is improbable.

Discussion

Grouting was carried out during construction of this dam. The leakage that was reported after completion of the dam was along the "blowoff line" and was not through the rock foundation. The foundation is in a sound, non-soluble rock, and not susceptible to alteration by ground water movement.

Sources of Information

1. Wood, G.R. and Kehn, T.M., (1968) "Geologic Map of the Swatara Hill Quadrangle, Schuylkill County, Pa." U.S.G.S. Map GQ 689.
2. Air Photos, dated 1969, scale 1:24,000.
3. Plans and Reports in file.

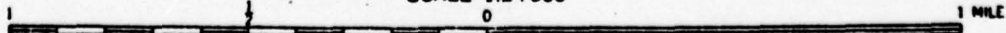
GEOLOGIC MAP - Sweet Arrow Lake Dam



(geology from U.S.G.S. Map GQ-689)

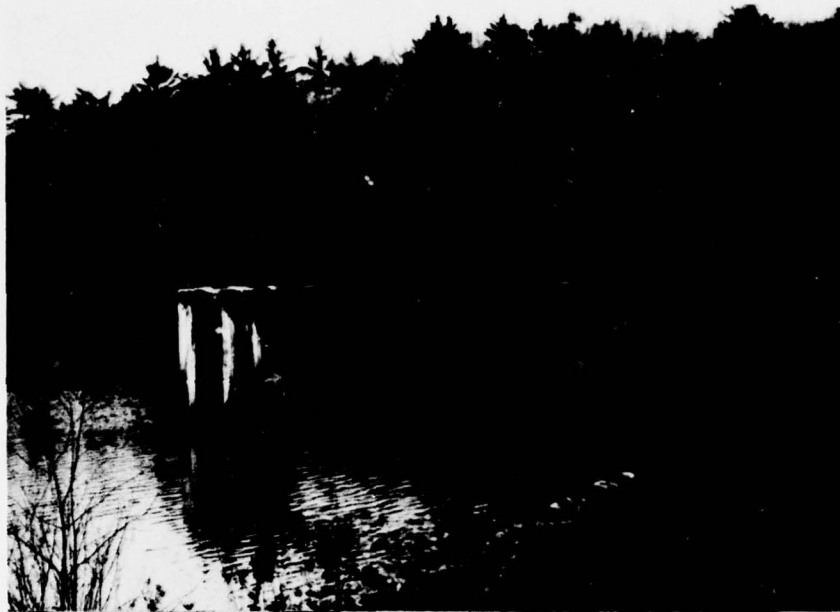
| | | | |
|-----|---|-------|--|
| Qal | alluvium | Dml | Mahantango Fm.- lower shale and sandstone member |
| Dcd | Catskill Fm.- Damascus Member | Dm | Marcellus Shale |
| Dci | Catskill Fm.- Irish Valley Member | Ds | Selinsgrove limestone |
| Dt | Trimmers Rk. sandstone | Dr | Ridgeley Sandstone |
| Dmu | Mahantango Fm.- upper shale member | Sb | Bloomsburg Red beds |
| Dmb | Mahantango Fm.- Montebello sandstone member | -?- - | thrust fault |
| | | -.-.- | air photo fracture trace |

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APPENDIX E
PHOTOGRAPHS

APPENDIX E



Intake Tower
& Footbridge



Trees on
Downstream Slope

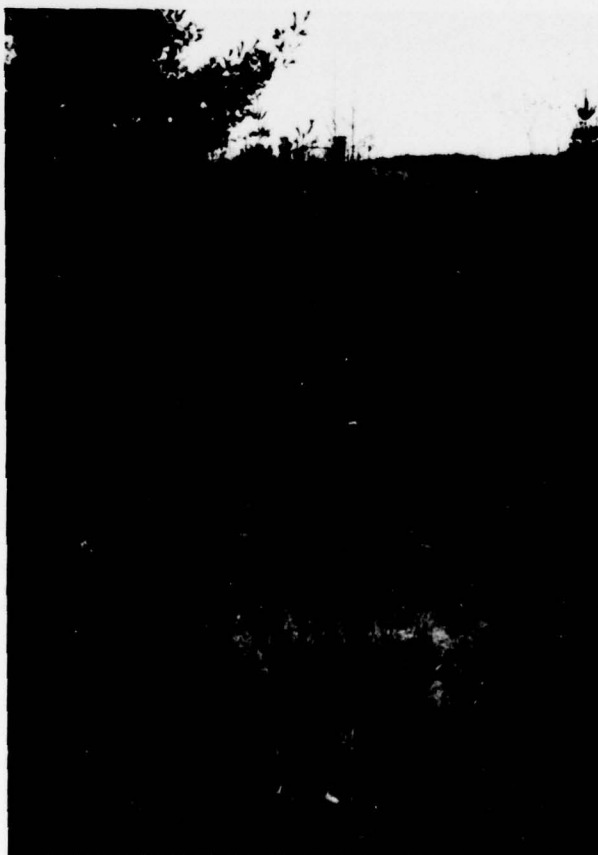


"Bike Path" on
Downstream Slope

PA-680
PLATE E-I



Erosion on
Downstream Slope



Rockfill Toe

PA-680
PLATE E-II



Entrance to
Spillway



Spillway Over
First 200 Feet



Spillway Channel
Just Above Drop

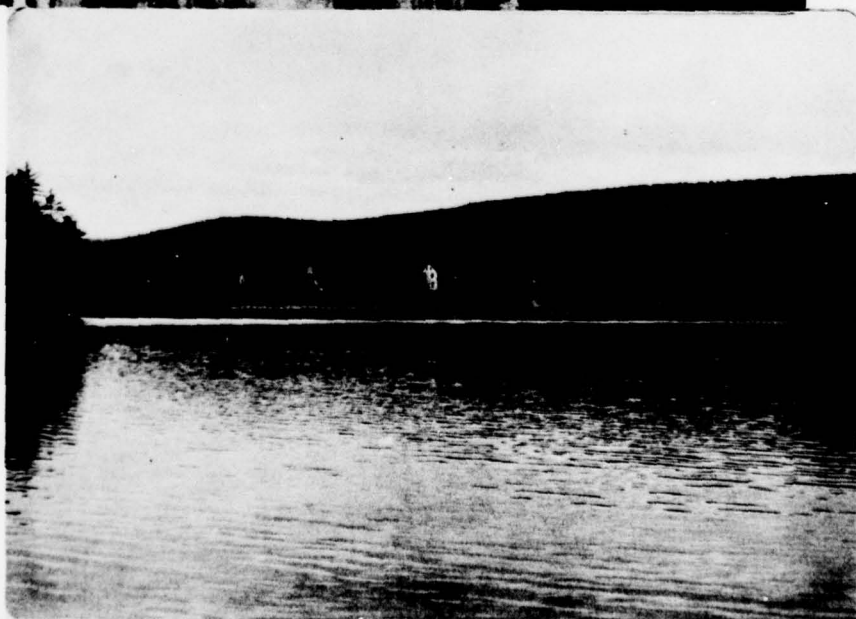
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PLATE E-III



Spillway



Conduit Outlet
With Creek in
Background



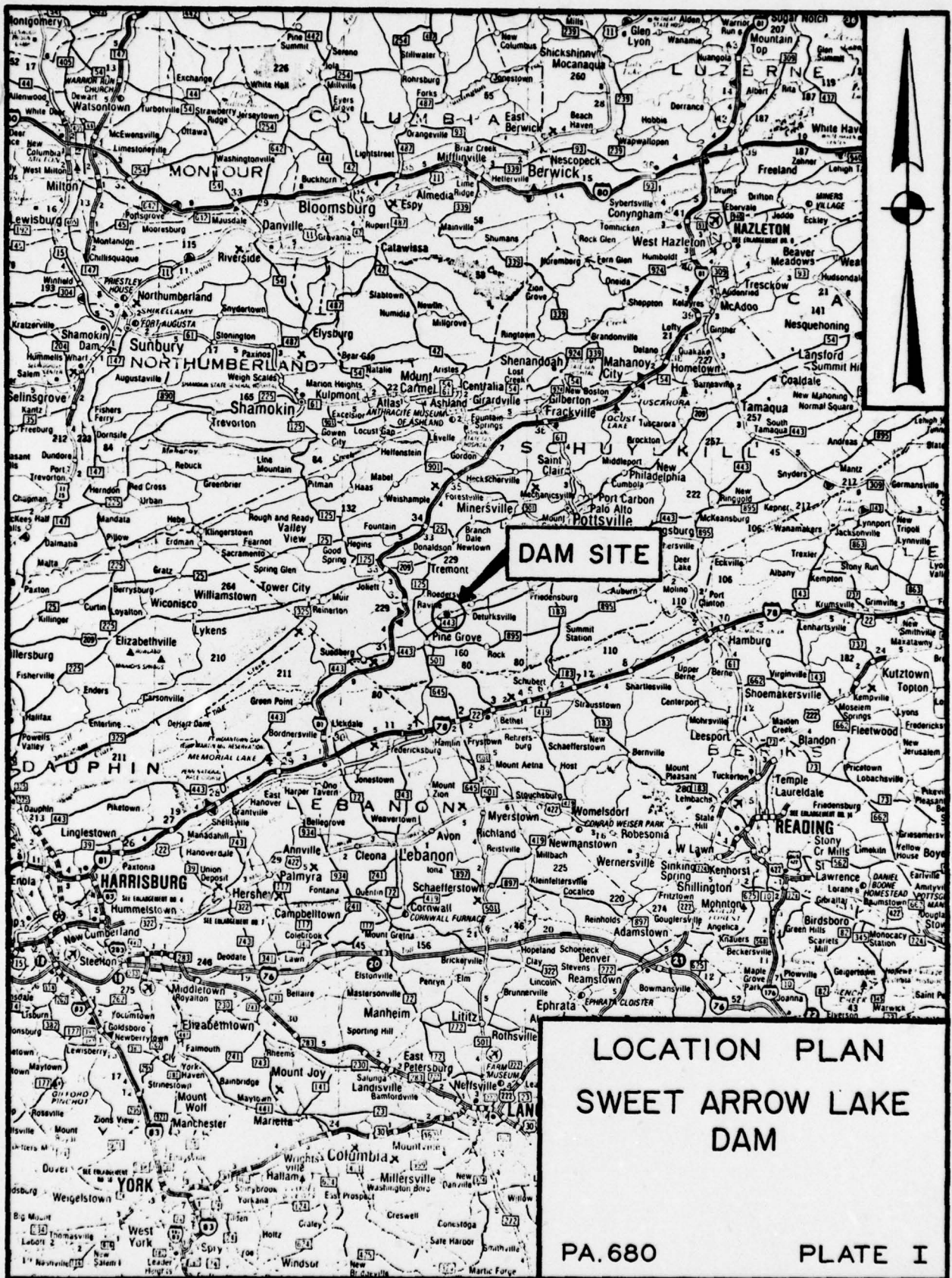
Reservoir

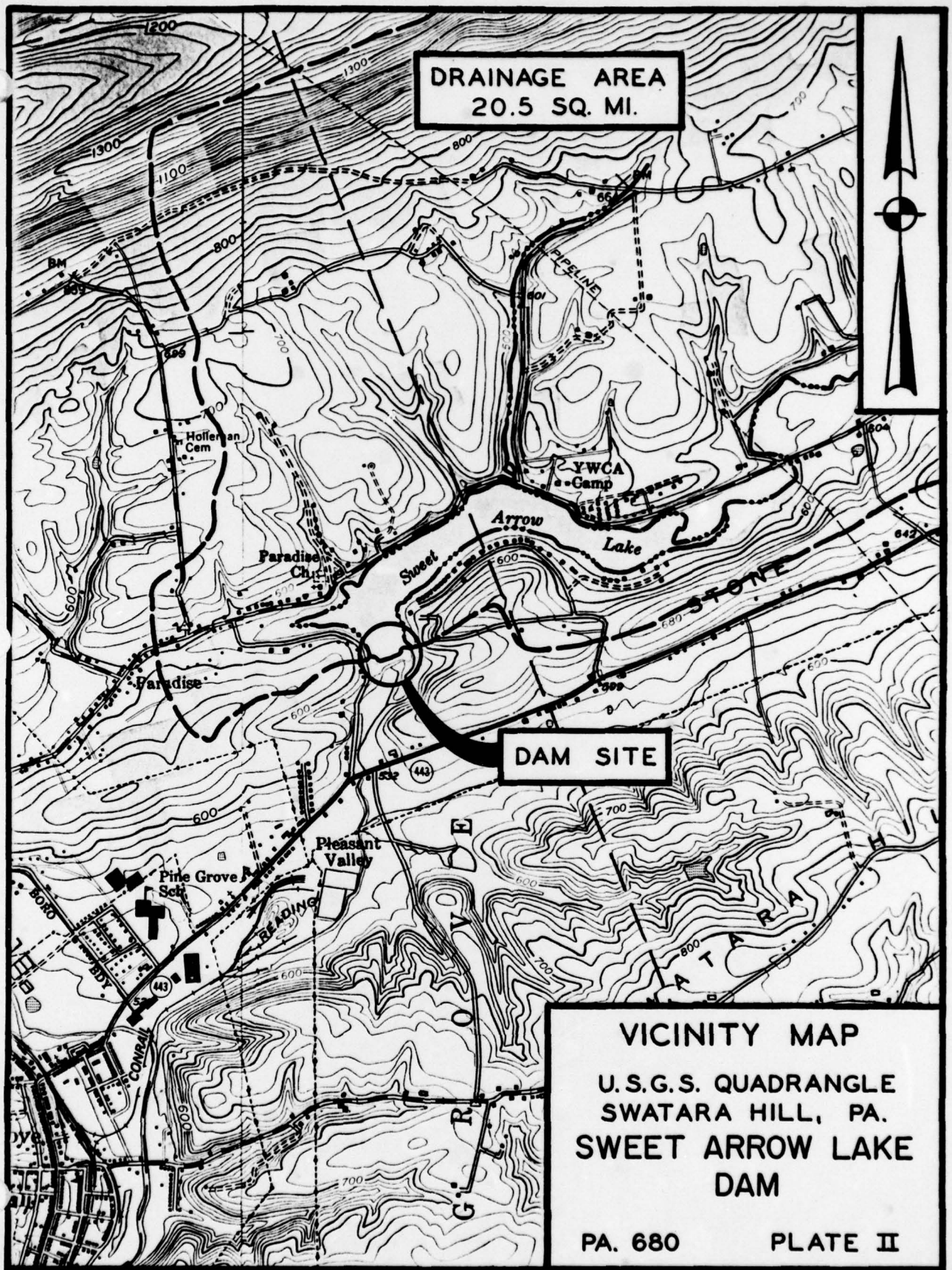
PA-680
PLATE E-IV

APPENDIX F

PLATES

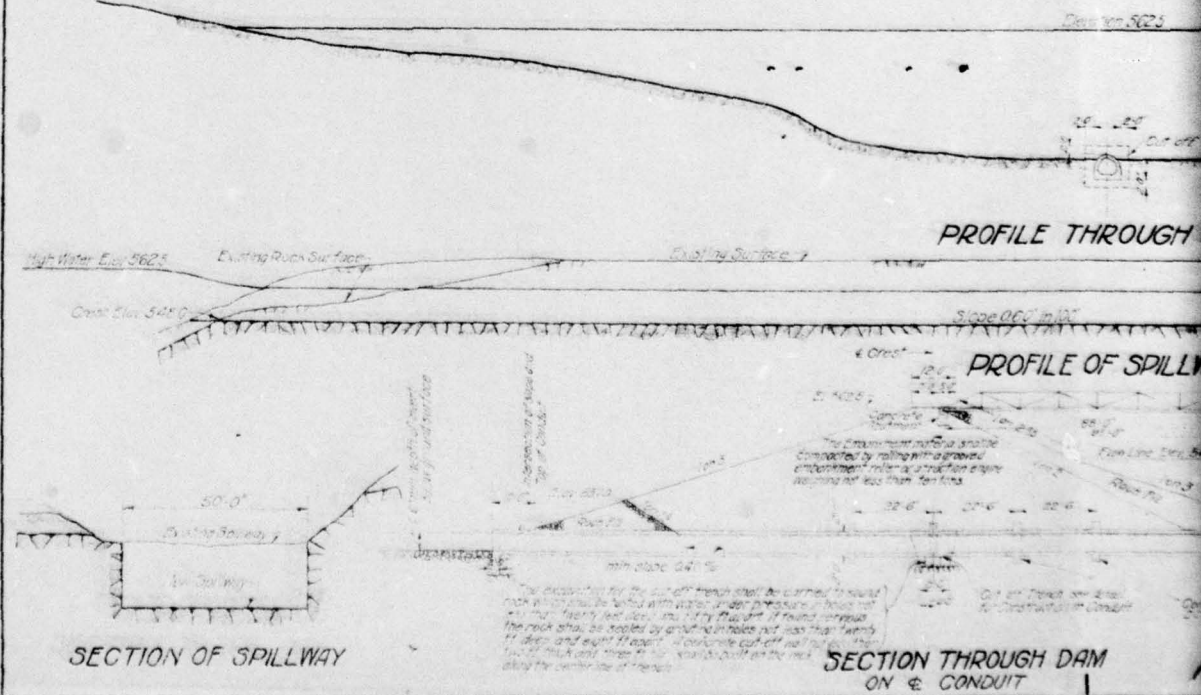
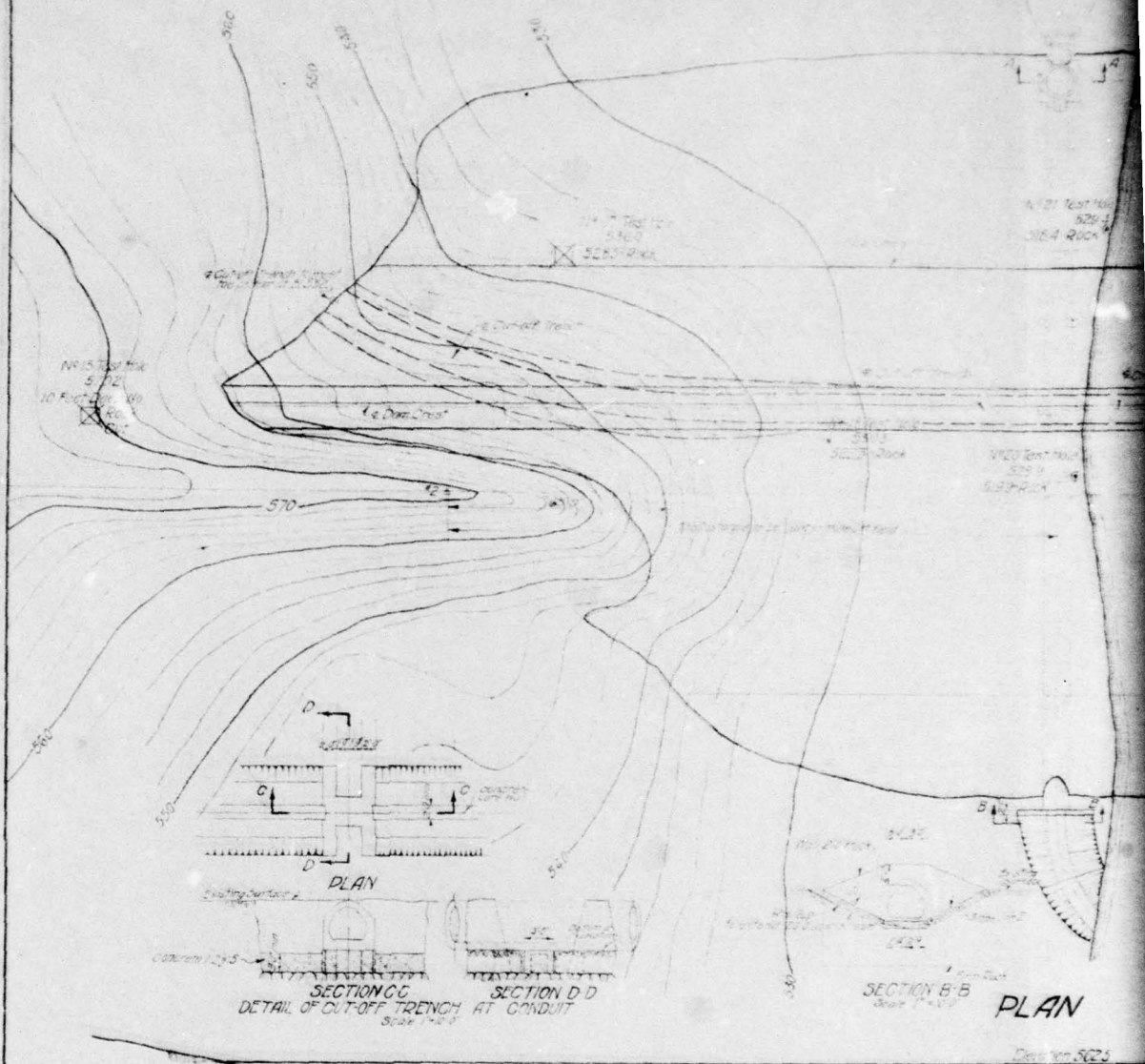
APPENDIX F

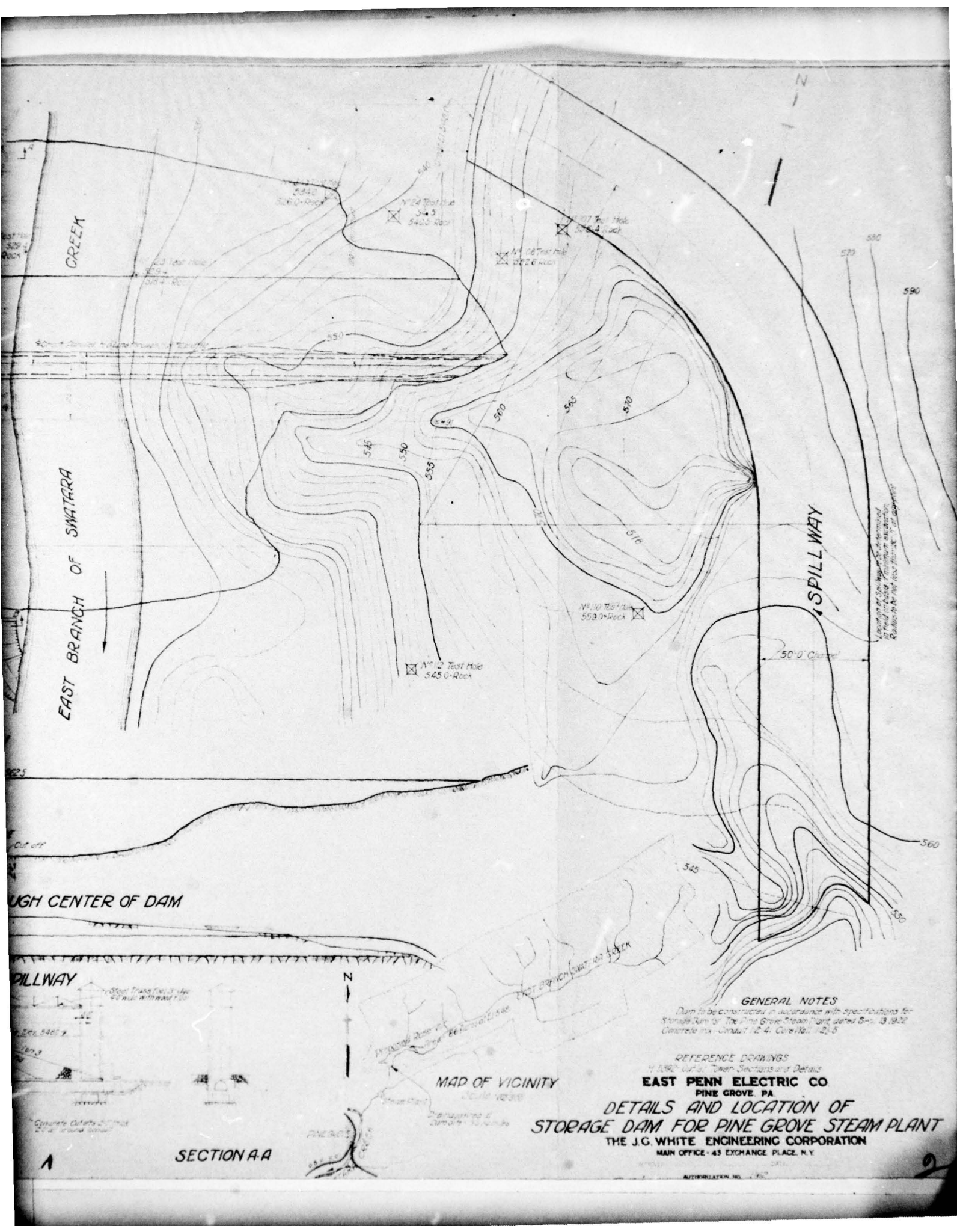




RECORD OF ISSUES AND REVISIONS

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520' 0" ROCK

CREEK

EAST BRANCH OF SWATARA

ROUGH CENTER OF DAM

PILLWAY

1" Steel Trans Field 3' dia
40' high with road 7' 0"

Box 5381

Concrete Culverts 2' dia
2' 6" at ground surface

SECTION A-A

MAP OF VICINITY

PINE GROVE
SWATARA CREEK

DETAILS AND LOCATION OF
STORAGE DAM FOR PINE GROVE STEAM PLANT

THE J.C. WHITE ENGINEERING CORPORATION

MAIN OFFICE - 45 EXCHANGE PLACE, N.Y.

GENERAL NOTES

Dam to be constructed in accordance with specifications for
Storage Dam for The Pine Grove Steam Plant dated Nov. 13, 1922
Concrete max. conduit 12' 4" Core Wall 12' 5"

REFERENCE DRAWINGS

N. 5, 1922 and 1923, Open Sections and Details

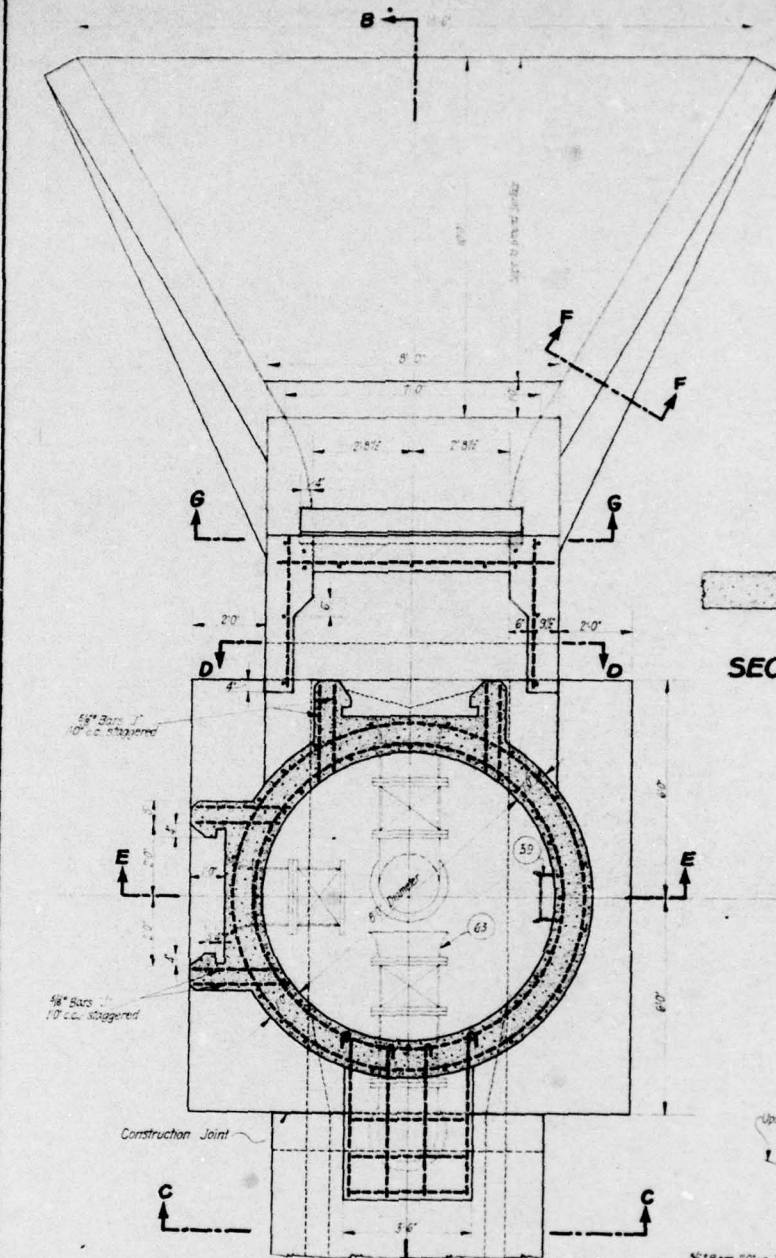
EAST PENN ELECTRIC CO
PINE GROVE, PA

AUTORIZATION NO. 1752

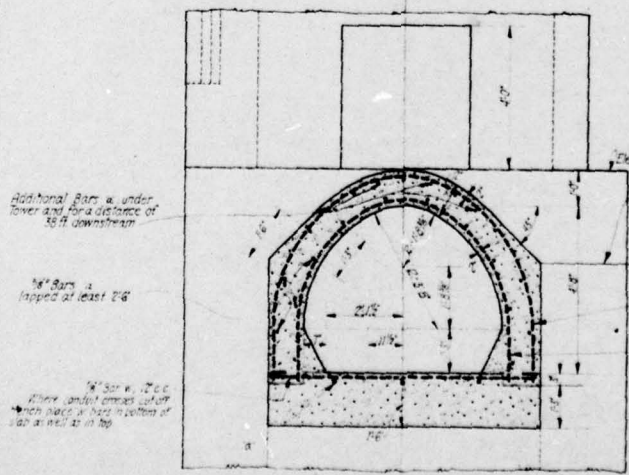
PA.680
PLATE III 3

RECORD OF ISSUES AND REVISIONS

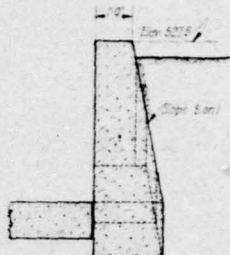
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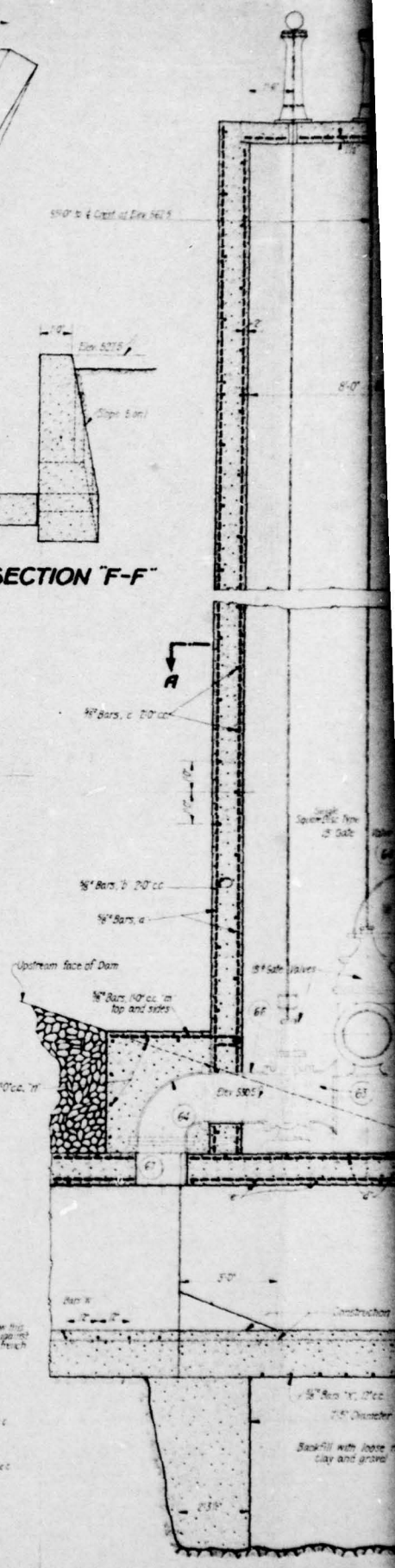
PLAN AT "A-A"



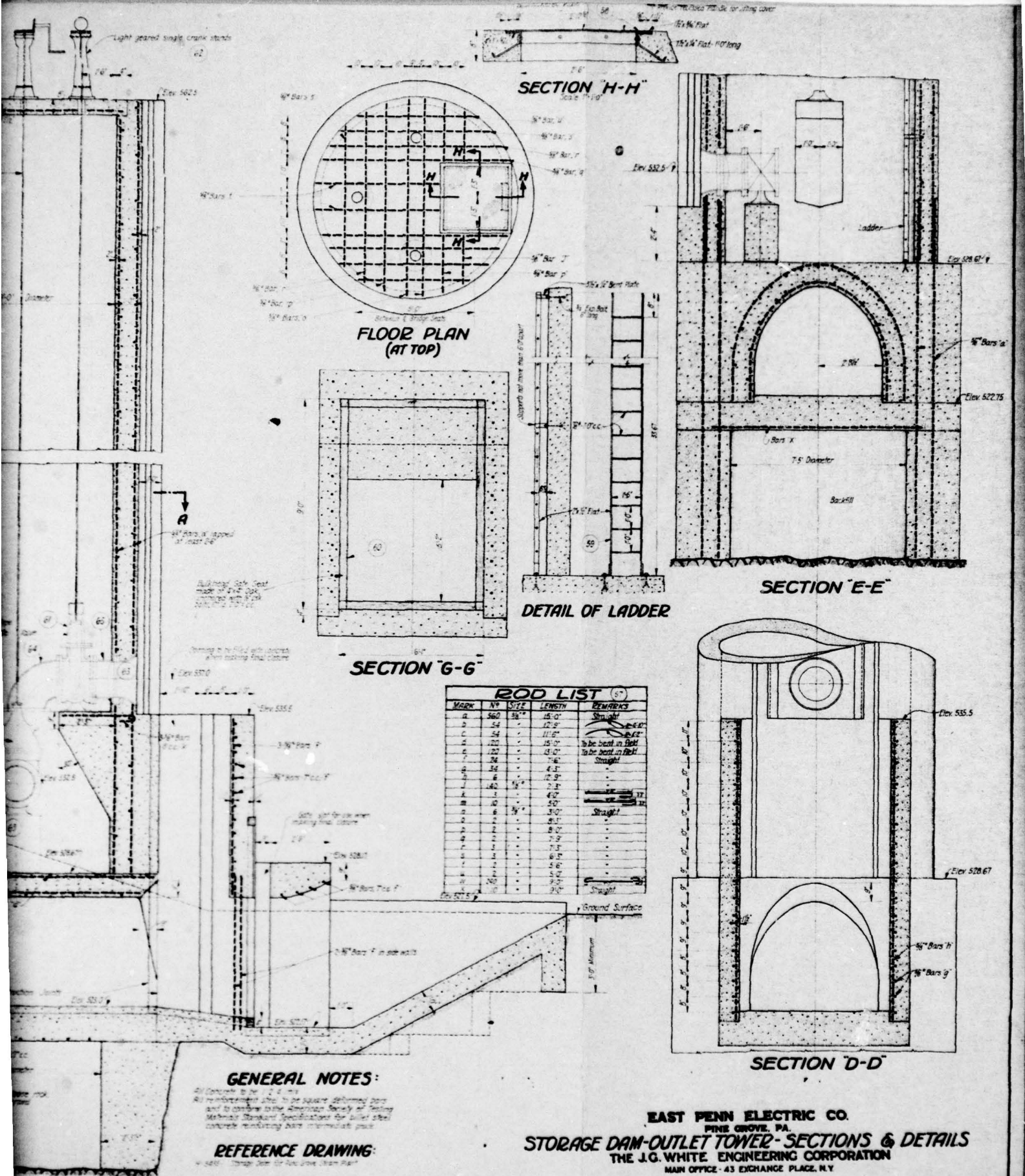
SECTION "C-C"



SECTION "F-F"



SECTION



GENERAL NOTES:

All Concrete to be 1:2:4 mix
All reinforcement steel to be square deformed bars
and to conform to the American Society of Testing
Mechanics Standard Specifications for steel bars
concrete reinforcing bars immediate grade

REFERENCE DRAWING:

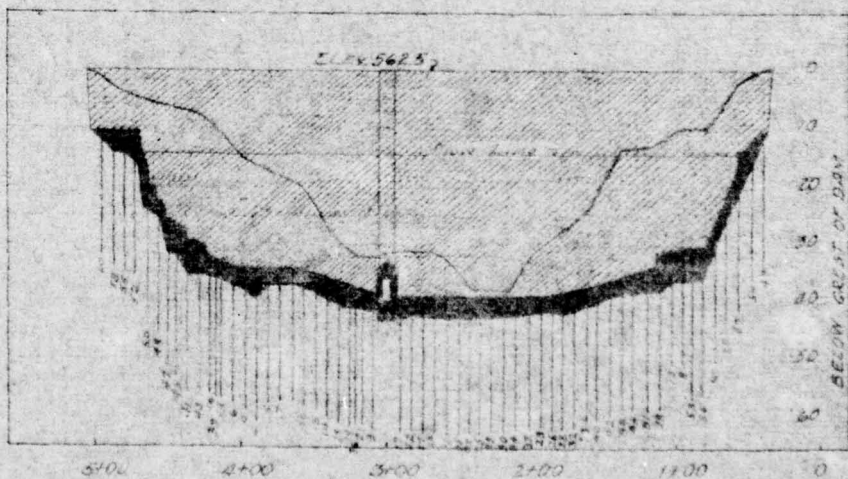
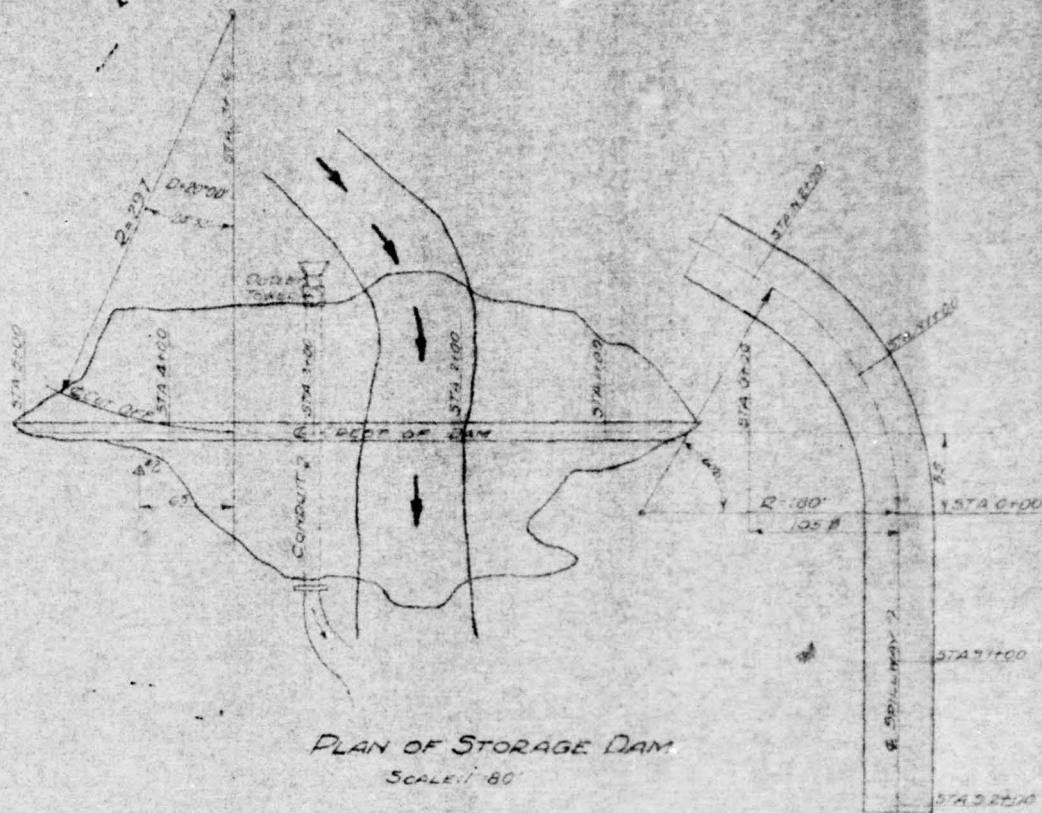
W-4401 - Storage Dam for Run-down from Plant

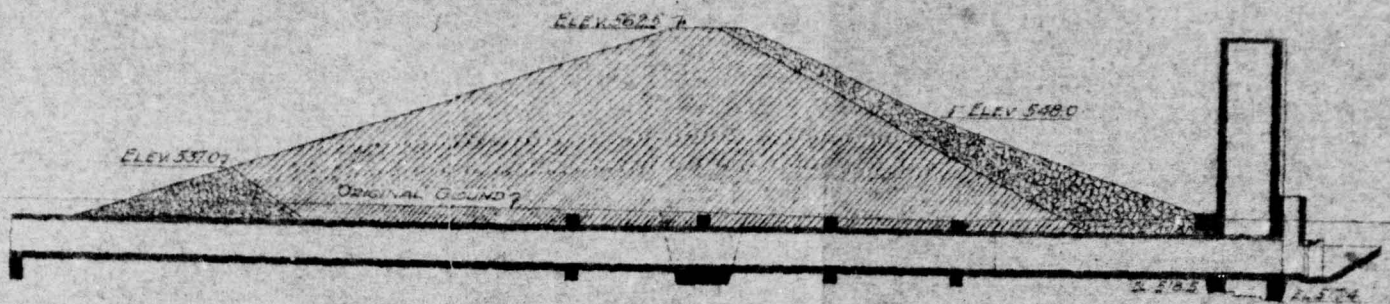
EAST PENN ELECTRIC CO.
PINE GROVE, PA.

STORAGE DAM-OUTLET TOWER- SECTIONS & DETAILS
THE J.G. WHITE ENGINEERING CORPORATION
MAIN OFFICE - 43 EXCHANGE PLACE, N.Y.

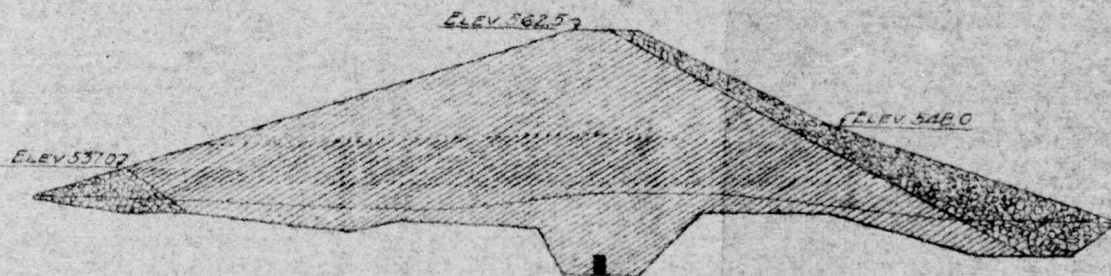
APPROVED _____ DATE _____
AUTHORIZATION NO. 1162
SCALE 1/4" = 1'-0" Except where otherwise noted

PA.680
PLATE IV₃





SECTION THRU DAM-STA. 3+00
AND ON & CONDUIT
SCALE: 1" = 20'



SECTION THRU DAM-STA. 1+80
SCALE: 1" = 20'

PROGRESS FOR HALF-MONTH ENDING **Nov. 15, 1973**

EAST PENN ELECTRIC CO
PINE GROVE, PA.

**PROGRESS
ON
STORAGE DAM**

THE J. WHITE ENGINEERING CORPORATION
MAIN OFFICE: 43 EXCHANGE PLACE NEW YORK, N.Y.
FIELD OFFICE: PINE GROVE, PA.
MARCH 29, 1973

PA.680
PLATE V 3